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ART. I.—*Sketch of a Journey from Canton to Hankow, through China;* by ALBERT S. BICKMORE, A.M.

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ON the 7th of August, 1866, I left Canton, in company with Mr. C. L. Weed, photographer at Hongkong, and Rev. Mr. Nevin of Canton, on a journey through the province of Kwangtung and the eastern part of Kwangsi. Our course, at first, was westward, for about sixty miles, when we reached the head of the great Delta of the Sikiang, whose low, fertile fields spread out widely along the river banks, and support a most dense population. Along the borders of these low lands, rise serrated mountains—some peaks attaining an elevation of fifteen hundred to two thousand feet—their sharp ridges and projecting spurs coming out in strong relief, on account of the scanty vegetation on their sides. To one who has been journeying in tropical lands, and especially among the luxuriant forests of Sumatra, these mountains appear surprisingly bare, and only the more so, when he considers that he is but on the verge of the temperate zone.

This nakedness appears to be a universal characteristic of the mountain scenery in China, but it is not the fault of the soil or the climate, for wherever the little pines have been suffered to rise, they show a vigorous growth. The cause of this universal devastation is the frequent rebellions that have swept back and forth over the whole empire, like a desolating flood.

In a few days the Chinese can rebuild their low mud houses; but Nature requires years to cover her mountains with forests; and rebellion has followed rebellion too quickly for her to accomplish the ever recurring task; and besides, the people do not care to labor much, when there is every probability that outlaws or robbers from a neighboring province will profit by their industry. Yet it is true they do raise some trees in a few places; but over all the wide area that I have traveled, not a tenth part of the soil is thus improved that might be; and then the trees are generally cut down before they attain any considerable size; and this, in districts where the population is numbered by the hundred thousand. The grand old trees which are occasionally seen around the Buddhist temples, owe their preservation only to the superstitions of the destroyers, and these show well what splendid timber thousands of hill-sides in China might yield.

But in regard to the low lands, it scarcely seems possible that they could be made to produce more than is already raised—two full crops being obtained in nearly every part of the empire. The continued fertility of these lands has long been a wonder to the world. It is due no doubt chiefly to two causes; first, the Chinese are careful to save everything that can possibly serve for manure—in some places even to the hair they shave from their heads; and secondly, their low lands (where all their rice and most other sustenance is obtained) are all, or very nearly all, subject to floods at least once a year, and a rich deposit of fine mud is thus spread over them, just as in the valley of the Nile.

Following up the Sikiang, through a deep pass in the first mountain range, we came to the city of Shauking, where the Viceroy of the provinces of Kwangtung and Kwangsi resided when the Portuguese first appeared off the coast. About two miles behind it rise the famous "Marble Rocks," or "Seven Stars," like dark, sharp needles, out of the low, green plain. Mr. Nevin and I measured them with an aneroid barometer, and found them to range from one hundred and fifty to three hundred feet high, though they had been previously estimated at twice that height. The rock of which they are composed is a highly crystalline limestone, of a dark blue color on the weathered surfaces, and a rusty iron tinge where large fragments have been lately detached, the whole traversed in every direction with milk-white veins, and completely fissured through and through, in every direction, by joints and seams. Over the whole exterior they are extremely rough and jagged, and furrowed by perpendicular grooves, worn by the small streams that course down their sides during every slight shower.

They form such striking objects in the surrounding plain as the "Little Orphan" does in the waters of the Yangtse, and, like it, abound in groups of little temples placed in the natural niches in their sides. Larger temples are ranged at their feet, and one which we entered contained in the principal hall three images in bronze six or seven feet in height. In another room I noticed an idol with six arms. The whole building was going rapidly to decay, and it was only after much searching that we succeeded in finding two poor old monks, preparing a scanty meal in the refectory,—the last place they were willing to desert in the whole temple.

Climbing up a steep, narrow stair-way, that rises diagonally across the face of the precipice, we reached a second temple perched high in a little rock. Along a part of this stair-way, a rude heavy chain was fastened to the mountain side, that the timid and weary might help themselves on to the temples above; and many must have been the pilgrims that ascended this difficult way, if we could judge from the depth of the places their feet had worn in the steps of the solid rock. The entrance to the temple was through a crazy gate-way or portal of loosened bricks, that leans over the precipice, and threatens to fall with the first person who sets foot within it and immolate him to a heathen god. This temple we were informed was built some two hundred years ago when Shauking was a great and flourishing city, but now the monks can scarcely beg enough from their poor neighbors to answer their immediate necessities, and their once splendid temples are rapidly becoming only unsightly heaps of ruins.

Here, as is frequently the case in masses of limestone, are several caves. We entered one of a bell shape. Its floor was mostly covered with water, and a bridge led us to a platform at the farther end. As we were crossing this Stygian stream, we were saluted with a fierce barking, and certainly we did seem to be approaching the regions over which Cerberus presides, but no other charm was needed for us to safely pass these canine guardians than a threatening show of our canes. Many tablets have been cut in the rocky sides and along a stair-way that led up to where the cave opens out to the sky at the opposite side.

During these excursions in the vicinity of Shauking, both of my companions became quite ill, and at my earnest solicitation finally consented to return and let me continue on alone.

On the second day from Shauking, I came to "Cock's Comb Rock," a huge wall or dike, of black or crystalline marble, with a crest so jagged that the name the Chinese have given it exactly describes it. Northwest of this, in a small plain, is

a conical hill of limestone, whose whole interior has been washed away, forming a much grander cave than the one we had previously visited in one of the "Seven Stars."

All the mountains in these regions are composed of fine, hard siliceous grits, which in some places are compact and flinty, becoming true quartzite or quartz rock, and in others are soft as sandstone; and besides these, of slates that are interstratified with these grits and are sometimes soft clay slates, and at others as hard as shales. Half a mile below the village of Kok-hau, on the left bank of the Sikiang, just before I reached the boundary of the province of Kwangsi, I found these grits and slates resting *immediately on granite.* Two miles below Kok-hau rises "Ornamental Monumental" Rock. It belongs to the lower part of this series of grits and slates, but is composed of a coarse conglomerate, and perhaps represents the conglomerates that are found near granite, in other parts of the empire.

Crossing the river from Cock's Comb Rock, we came to a small village, and anchored for the night astern of a small gunboat. On consulting my chart I found these words written around the next bend, about half a mile up the stream,—"*a favorite resort for robbers!*" But I believed we must be safe with a gunboat so near, and taking care that my revolver was in prime order, and that a heavy sword was within my grasp—a provision that was constantly repeated every night of my long journey—I laid down determined to sleep, despite a continual din of tam-tams, and the most extravagant shrieking and groaning of some women on the bank, who were lamenting the decease of a friend.

Late in the night the watch began calling out loudly, then my servant and my boatmen joined in. A strange boat was stealing along toward us, and although it was already so near that I could hear the noise of its approaching oars there was no reply. At the next instant the gunner on the watch-boat fired his cannon and at once the men in the suspicious boat all answered in the meekest and most humble tones. Our would-be robbers had that time mistaken their prey. This is but a fair example of the noises and alarms that were constantly recurring by night all the way to Hankow.

As we slowly ascended the river by poling, tracking and sailing, we stopped several times a day, that I might collect specimens of the rocks and ascertain the dip and strike of the strata. In this way, in a week we came to Wuchau, the last missionary outpost in this direction. Here I met the Rev. Mr. Graves, and induced him to accompany me up the Kweikong, or Cassia river, as far as Kweilin, the capital of the province of Kwangsi.

It is so dangerous ascending this river, on account of robbers, that boats leave Wuchau only when several are ready to go and can keep together and afford each other mutual assistance in case of an attack. As an additional protection, the Mandarin offered to send a small gunboat along with us, but when we were ready to go, only one policeman appeared and he carried no arms.

The boats used on this river are quite different from those seen at Canton. They have flat bottoms and curve up high at the bow and stern, that the helmsman and a man on lookout forward may see some distance ahead and avoid the rocks, as they come down with the rapid current.

The principal article carried up the river by these boats is salt, which is a government monopoly; and, notwithstanding our boatmen all agreed not to bring a particle on board, they did buy a considerable quantity, and tried to hide most of it in our part of the boat. We very plainly informed them they had not kept their agreement, and if they left it there it would instantly go overboard. They finally, as near as I could ascertain, bought a permit for a part of it and smuggled through the rest. This smuggling is so common, that I was repeatedly informed that the Mandarin boats, which are not liable to be searched by the custom-house officers because they carry high officials, never fail to improve every opportunity to avoid paying the regular tax.

As we passed along these rivers, every day or two we came to a small house with two poles in front, each bearing a large triangular flag. There we were obliged to stop, and allow our boat to be searched by fierce looking fellows, each armed with a long stick pointed with iron. Ascending this Cassia river is little better than dragging a boat up one continued series of rapids; and though ours drew but five or six inches, it seemed sometimes as if our boatmen would be quite unable to get her along any farther. This fact indicates the shallowness of the stream, and also the unfavorable fact, that steamers can never be used on this river. The boatmen at Wuchau calculate to reach Kweilin in fourteen days, but to go all the way back in four.

For the first hundred miles we passed only small, scattered villages, each having on the top of the highest hill near it a fort, where they keep all their extra rice and clothing—every thing they use from day to day—for every village pillages on every other village, and on all the boats that pass, whenever they dare. These fortified hill-tops reminded us of the pictures drawn by historians, of the middle ages; but these people observe even less law and order than those of those early times.

As an illustration of the complete state of anarchy that obtains throughout all this region, I may mention that on our third day from Wuchau we passed a large *Mandarin* boat that had been robbed of everything the very first night after leaving Kweilin, the officials even not being able to protect themselves from these desperate thieves.

All along our route the Mandarins were very kind to us, but kept asking how we could dare to come there, where only one foreigner had ever been before, and who, though he had escaped the people of Kwangsi, was murdered by the people of Hunan. They referred to an eccentric genius, who did succeed in reaching Hankow, but was completely stripped of all his clothing. His difficulty with this people was certainly one cause of their hostility to us.

Beyond the hien city of Chauping, the country becomes somewhat more cultivated, yet even here it is very sparsely peopled, and there is no need that a single man should leave China to find plenty of good land to cultivate. The river here flows through deep passes, and we entered one called "Forest Pass," as the bright day was darkening into twilight. The rock was a hard siliceous grit, and sharp peaks in the range rose up to a height of 1600 or 1700 feet. Like the famous Shauking Pass, this is also a cleft in a mountain range; but while that is about 600 yards wide, this is only from 50 to 150, and as we sailed between the high, almost overhanging precipices, the effect was far grander than anything I have ever enjoyed in China.

As night overtook us while in the pass, we moored our boat to some huge rocks by the steep bank, and then climbed to the edge of a neighboring ridge and waited for the full moon, whose soft light was just then brightening the eastern sky; and when her silver disk rose over the jagged edge of the high peaks above us and threw long pointed shadows down the steep-sided pass, we had before us such a view as a lover of crayon sketches might well roam the whole world over to enjoy.

As we approached Pingloh, a high range of needle-shaped peaks stretched across the river from east to west. They were composed of the same dark blue, highly crystalline limestone traversed with white veins, that had been previously noticed in the Seven Stars at Shauking and Cock's Comb Rock on the Sikiang. Here the pass gave a section showing this limestone resting on the previously mentioned grits. In the muddy places were large quantities of a beautiful blue *Convolvulus* in full bloom, of the same species as specimens Mr. Graves had frequently found in the limestone caves near Shauking.

Our daily routine was to walk in the forenoon until the sun got high, and again in the afternoon until the boat reached a safe anchorage, Mr. Graves collecting plants and sketching a map of the river, and I gathering geological specimens, ascertaining the dip of the strata and the direction of the elevations, details too numerous to be given in full in this hasty sketch.

On the evening after leaving Pingloh we were following the river as it bent around a high bluff, when we suddenly found ourselves on the edge of a valley, ten or twelve miles broad, and extending farther than we could see to the right and left. In every direction this whole valley was perfectly *bristling* with sharp peaks of limestone. The strata of this limestone were nearly horizontal and once the whole valley was filled with solid rock, which, in the course of ages, had been worn into deep channels that have been kept widening until only sharp peaks are left of what were originally continuous sheets of rock. From a single position on the low river bank I counted *one hundred and ninety-two* separate peaks. The highest I judge rose 1200 feet above the plain,* but even this did not represent the original depth of the deposit. These dark rocks, rising abruptly up from the low, level lands at their feet, contrasted most strikingly with the bright light green of the fertile plain and made this view the most picturesque and remarkable seen on this journey. A similar view is to be enjoyed among the contorted and fractured Devonian rocks on the banks of the Tchussovaya, on the western flanks of the Ural; and it is probably to this same Devonian period that these limestones, and those previously mentioned, belong.

On passing out of this limestone region, a section was obtained a little above the market-place, Hingping, where these limestones were seen resting (*conformably* as near as I could ascertain) on the grits that at Kokhau were in them found resting on granite.

About Kweilin, the capital of the province, the valleys are much broader and better cultivated; and large water-wheels, twenty or thirty feet in diameter, are common along the river banks where the rapids are strong enough to keep them moving. Pieces of bamboo are fastened to the rim at a slight angle, and bring up the water and pour it into a trough as they reach the highest point and begin to descend on the revolving wheel.

A small pagoda, perched on the top of a ragged rock, and a

* As we could not learn that this peak was known by any particular name, I propose to name it Longfellow's Peak. This and all the surrounding limestone needles appear like high columns that once supported the roof of one immense temple.

high wall of limestone, through which had been chiseled a large hole, were pointed out by our boatmen as indications that we were nearing the capital of the province of Kwangsi. Instead of being situated on the west side of a lake, as represented on the best maps, we found it on the west side of the Kweikong river, which in the rainy season probably overflows its banks. The walls of the city are of limestone blocks neatly cut, with a parapet of bricks.

We carefully closed our boat and in the evening rowed up to the city. I at once dispatched my servant to the Yamun—as the Chinese call the place where their officials reside—to ask for chairs and policemen to protect me as far as the next city, but all arrangements could not be completed till the next day. Meantime we were careful not to let any one see us, but in some way they found we had come, and early the next morning all the streets and boats near us were perfectly packed with people anxious to get a sight at the foreigners. At first we tried to escape by ordering our boatmen to move, first to one place and then to another, and thus we darted hither and thither like a bird trying to escape from a hawk, but everywhere we found a greater and greater throng, and finally we concluded it was best to try to partially gratify their insatiable curiosity by going out on to the forepart of the boat and exhibiting ourselves by turns.

When one crowd had satisfied their desire to see "the barbarians," they generally left us but they were immediately replaced by one still larger, until it seemed as if all the Chinamen south of the Great Wall had come out to gaze at us. Meanwhile my servant arrived from the Yamun, saying that all was ready, and the Mandarin begged if I was going to Hankow that I would depart at once, for the whole city was so much excited by a proclamation issued by the gentry, that he feared we would be attacked and he would not be able to defend us.

Mr. Graves kindly translated the proclamation for me. It ran as follows :

"It has already been determined, by common consent, that if any one has anything to do with the Imps, or rents them a house or any other dwelling place, his house and his family dwelling shall be immediately burnt to the ground, and his whole family, male and female, old and young, shall be at once put to death.

"By Order of the Whole Provincial City."

Despite this formidable threat, I determined to continue to push my way through to Hankow, or perish in the attempt.

A great crowd gathered on the shore where I landed and the boys hooted and shouted, but I could not understand what they said and only hurried on my chair bearers through the suburbs, which were everywhere perfectly thronged. Two or three times

I feared they would block up the street in front of me and stop me completely, but they seemed to have a suspicious regard for the barbarian and concluded to allow me to pass on.

When we came to the chief gate and were entering the city, some officials stopped my chair and drew me up into their office out of the press of the crowd, while they were instructing my coolies to go *round* the city and not *through* it. One of my chair bearers took this opportunity to run away and it seemed an age before another could be found; but finally I continued on between the city wall and the river until we came to a great rock, round which we were carried in a boat, and thus we were at last freed from our tormentors. It gave me a most delightful sensation to find myself once more able to walk, so that I might hurry on my chair bearers to the top of their speed and thus, with all possible haste, distance this City of Destruction! Night, however, overtook us when we were five miles away and the two policemen guarding us selected an inn in a little village, where we lodged for the night.

After such a frightful tumult, it seemed so safe and so sweetly quiet that I was tempted out a little way into an adjoining field to note, by aid of my azimuth compass, the direction of the valley we were to travel in on the morrow and the form of the mountains that bordered it. While I was thus absorbed in the beautiful view before me a villager chanced to pass by and notice my open compass, so I shut it up and went back to rest for fear he might think I was like some of their own people—a geomancer. Later in the evening the whole neighborhood began to resound with a heavy beating of gongs, and soon a large crowd gathered in front of the inn, shouting out in the most fiendish tones, "*Kill him! Kill him! Kill the white devil!!*" I plainly saw that they had come with the determination to rob me and then kill me. I realized the danger of my position and I feared the worst, for how could one man defend himself against such an infuriated mob.

But my policemen proved firm, and at once showed the ringleaders my pass from their own Mandarin and assured them that if they injured me in the least their Mandarin would take every one of their heads off and completely destroy their village. Then their wrath took another channel and they cursed the Mandarin, and finally, after much angry disputing, they offered to go away on the condition that I should leave their village as soon as daylight appeared. My servant assured them that they need have no fear that I should remain *there* long, and that I certainly should not have stopped short of the next village if my coolies and policemen had not refused to travel any farther that night. The only crime alleged against

me was, that one of their number had seen me with a mysterious instrument observing the mountains and valleys, and that they were all satisfied that I had come to take away the treasures which they believed their land possessed. Almost everywhere over the whole empire, wherever they saw me breaking the rocks or observing the dip of the strata, they at once concluded I was searching for gold or silver or precious stones. Another common belief is that a foreigner who has blue eyes certainly has the clairvoyant power of looking three feet into solid rock!

The next day at early dawn we started up the valley to the north-east, the general direction of the Kweikong above Kweilin. The road, or more properly path, was three or four feet wide and paved with blocks of limestone and small rounded boulders from the bed of the neighboring river. Large numbers of coolies were passing to and fro, this being one of the four great highways between the southern part of the empire and the valley of the Yangtse. The others are that from the province of Kwangtung over the Great Meiling Pass into the province of Kiangsi and down the Kan river to Poyang Lake; another from Shauchau to Lohchiung and over the Lesser Meiling Pass; and the fourth from Yunnan, the capital of the province of that name, to Kweiyang the capital of Kweichau and thence down the Wu river to the Yangtse.

At 10 A. M. the road came to a small tributary of the Kweikong coming in from the northwest. On each side of this stream there had once been a large flight of marble steps nicely cut and carefully laid up, but when I passed they were all falling apart and the whole work going to decay, the amount of travel at present not being sufficient even to keep them in repair.

On one bank was a small square pagoda-like tower, and near it two great iron pillars surmounted by a large ornamental cap. Around each pillar was an iron ring and to this was attached a series of huge chains large enough to anchor a sea junk. The people said they were to fasten robbers to, probably the Miautse who live in the neighboring mountains to the north and northwest and who are said to come down frequently and plunder the smaller villages. Notwithstanding this formidable array of iron pillars and great chains, these Miautse have maintained an uninterrupted independence, a proof of the continued weakness of the Chinese government in every dynasty.

At 2 P. M. we stopped to lunch at a small inn. The policemen insisted on my going into a small room and remaining there out of sight till we were ready to start again, and after that all the way to Hankow, a distance of some 800 miles, I was so

strictly guarded and attended that I found myself really a prisoner. I could not make detours to the right and left as I pleased when we were passing some object of special interest. My compass I was compelled to secrete under my waistcoat, and I dared to use it only when we were far away from any village, and the road clear of coolies, and even then my policemen generally manifested a belief that I was little better than a spy, and my servant always felt it his duty to remind me how nearly my using it before had come to costing both of us our lives.

2 P. M. we came to Lingsun a hien city, 60 li by the way we came from Kweilin. I must confess that a sickening sensation closely akin to fear crept over me as I entered the gate of this city and thought of the danger I had passed through the day before at Kweilin.

The Yamun was near the gate we entered, and the officials that quickly gathered round all seemed to regard me with pity rather than hate. I tried to show my appreciation of the kind feelings they manifested by naming the places I had passed and marking out a rude map on the wall, but my policemen were afraid another mob might gather and therefore led me away to a little dirty inn where every room was full but one, and on one of the two beds in that an old opium smoker lay stretched out nearly stupefied with the intoxicating drug. Our room was more properly a dungeon than a guest chamber. A single fragment of glass in the roof, which was little higher than our heads, admitted all the light we were permitted to enjoy. But my companion, at least, was blissfully indifferent to the inconveniences of our prison and no doubt was imagining himself floating on clouds in the high air or in some richly gilded barge quietly gliding down Lethe's stream, whose waters he had certainly drank to satiety.

Small boys climbed up the partitions to peep over and steal a sight at me, but I was then quite accustomed to such slight annoyances. Meanwhile numbers of the curious of both sexes gathered in an outer room, and as a cloud of dust rose from the dry matting on the *kang* whenever I moved, it soon irritated my nostrils, and the whole party outside set up a loud laugh to think that such a strange animal could *sneeze!*

After three hours in these uncomfortable quarters, we continued on through the city and passed out the eastern gate. The whole city is merely one heap of ruins and there are scarcely houses enough left to line the main street, so complete is the destruction made by the Taiping rebels. In fact all the way from Chauping I had come almost exactly in the track of these rebels, and their hordes were composed of just such rob-

bers and desperadoes as I had found there. Their leader was undoubtedly stimulated to his undertaking by chagrin at not being able to pass the government examinations, almost the only way open to the subjects of that empire to obtain honor and wealth. It would be strange indeed if, as some people suppose, a man whose prime motive was to take revenge on his government should care much about elevating his countrymen. It is true he and his confederates invited foreigners to participate with them in overthrowing the dynasty of the Manchus, but I believe that they did this only because they needed assistance, and that if they had once gained the supreme authority they would have been as hostile to foreigners as the present dynasty; and a partial proof of this appears in the reserved manner in which their chief conducted himself as soon as he had secured Nanking and believed the whole empire within his grasp. This territory where the "Great Peace" rebellion began, and the territory too that they held the longest, is the most despoiled, the most dangerous and the most unpromising of any I have seen in my long journeys over China. Revolution has followed revolution throughout the whole length and breadth of China until her soil has been reddened with the blood of tens, even hundreds of millions of her people, and yet she remains just where she was two thousand years ago; and simply because all these movements have been originated by those whose only desire was to get the throne, to plunder or to avenge personal wrongs; and not by high-minded, generous men, having in view the good of their fellow countrymen.

A walk of 35 li brought us to Tai-ung-gong, a small village on the Kweilin or Cassia river, for the water still flows toward Kweilin. Before we reached it we crossed a small stream flowing into the Kweikong from the north. In its bed I noticed pebbles of granite and porphyry, but all the rocks seen *in situ* were the common siliceous grits. Here were many rafts of bamboos to be floated down to Kweilin and Wuchau. The valley here is filled with small hills, but in this place only. Among them I gathered a beautiful blue bell quite like that found on our own hillsides in New England. A kind of blackberry that grew in the old ruins by the way side was just ripening, and the opening of the asters also heralded the coming of autumn, as at home. I had chosen the best season of the year for this journey, for there is far less danger from the people when it is harvest time and they are not suffering from want of food. The next day we traveled 55 li to Hingan, a hien city. The water here flows to the north and the water-shed is a few li to the southwest. It is not natural but artificial, and what were originally small streams have been changed into canals and

these extended to head waters of the Siang. The water is kept for a time in these rivers and canals by building dams across them whenever a rapid would occur and allowing the water to escape only over a small gap deep enough for a single boat to pass over. Hingan is in the same ruinous condition as Lingsun. It is 150 li in a northeasterly direction from Kweilin. The Siang here was so low that I had to go 17 li farther to the village of Tankatse to take a boat for Sinchau, 140 li down the river. All along this route the water was so low that we were continually thumping and bumping and grating over the rocks and coarse shingle, especially in the dams which we met every one or two li. They are made with a gap for the boat to pass over near one bank and near the other a sluice-way, where as many as ten great water wheels were sometimes seen, one behind the other. It seemed as if there were more rapids in the 14 leagues from Tankatse to Sinchau than in the 16 leagues from Kweilin to Wuchau on the other side of the water-shed. Sinchau is the chief city in this region and appeared nearly as large as Wuchau. It is not in the province of Hunan but in Kwangsi. At the boundary of these provinces dark shales appear apparently resting on the limestones over which we had been passing on our way down the Siang.

At Sinchau my servant and boatmen purchased some fossils, which all agreed in saying came from a waterfall 93 li distant among the hills. Small boys gather them at the foot of the fall and bring them to market to sell for curiosities. They were Brachiopoda, probably of the Devonian period, and from the curved parts near the hinge the Chinese call them "hawks." A Mandarin afterward gave me the same account of them. They come from the limestones already described as resting on grits and slates.

The boundary between the provinces of Kwangsi and Hunan is about 100 li down the Siang from Sinchau. There only low hills border the river, and the valley of the Siang really begins. All the way from Shauking near Canton to this point, the whole country is one mass of hills.

All through the province of Kwangsi I was attended by one or two policemen, who carried a large paper from their Mandarin saying to all his people that I was traveling through their country with the permission of the Imperial Government at Peking, and forbidding any one to oppose or annoy me. When we came to the next city this paper was countersigned by the Mandarin of that place to show that I had reached his city in safety and that those policemen were absolved from any farther responsibility. But all through the province of Hunan I was constantly guarded by one civil Mandarin and one policeman,

and one military Mandarin and from two to four soldiers besides.

In eight days from Sinchau we reached Kiyang, which is situated on the left bank of the river and not some distance back from it as placed on the maps. Below this city the whole country becomes thickly populated and well cultivated, and the temples outside of the cities, which were nearly all destroyed by the Taipings, appear everywhere newly built, contrasting most favorably with the ruinous condition of such buildings in every other part of the empire, and indicating how well the people were prospering by whose contributions they were built. They are so numerous and form such a conspicuous part of every view along the Siang, that Hunan may well be styled the province of temples and the strong hold of Buddhism.

Eight or ten li below Kiyang, on the right bank, strata of limestone were seen resting very unconformably on other limestone strata as if the upper layers belong to an entirely different formation. Nothing of this kind had been seen before. The lower limestones had the jointed and fissured appearance of that previously noticed. Eighty-four li below Kiyang, at the village of Pin-cha-bu, we passed a hill of limestone *interstratified with coal.* They were quarrying the lime rock and using the coal obtained at the same time to burn it to lime. The dip of these strata is 40° to the north. A little farther in that direction came red sandstone with a similar dip of 15° to 20°.

Sept. 16th, stopped for the night in a little village 165 li above Hangchau. As we arrived after dark no one saw me and I was left unmolested. All the evening there was even more loud talking than I had been accustomed to hear, as if most of the village had been indulging rather freely in samshoo. At night we always anchored in the stream, and that evening my servant asked one of the Mandarins if he would like to take a walk along the front street. But he only shrugged his shoulders, shook his head in an ominous manner and said, "they are all the worst of ruffians there!"

About ten o'clock a loud talking and disputing began on the bank near us and soon one man commenced screaming and groaning as if had received his death blow. Immediately his murderers brought him down the bank, put him in a small boat and paddled out by us into the middle of the stream, their victim all this time groaning more and more feebly and evidently dying. My servant who was on the watch then informed me that this man was a merchant and belonged to another village and was taking some money to Hangchau, and when the people there robbed him and he shouted out for the police, they stabbed him and were finishing their work by sinking him in the

river. By this time, after the evil was done, the Mandarins at Yamun began firing small cannon every ten or fifteen minutes; and this they kept up regularly for some two hours, showing plainly to us all that they expected to be attacked next themselves.

I found we had thus unwittingly ran directly into a nest of those assassins who prowl in bands over the whole country. I trusted however that no one had seen me, for that was my only hope of saving my life.

Nothing remained for me to do but keep as quiet as possible and leave the place at the earliest dawn. I therefore sat down quietly, opened the lid of my revolver box—for I believe it is a duty every one owes to his Creator to save his life at any cost until he is convicted of some crime—and coolly determined when the event came to sell my life as dearly as possible. But after listening with the keenest solicitude for many long, lonely hours, I finally fell asleep, and when I awoke again our boat was floating down the stream and this village of assassins was far out of view behind us.

We soon came to Lichang the principal coal mine on the Siang. It is situated on the left bank of the river some 50 miles above Hangchau. The coal beds here were seen resting on limestone, and this is also the case in Sz'chuen, at the coal mines near Peking, and probably in every part of the empire where both occur. On the coal strata rests a red sandstone, which originally covered all these coal deposits, at least, in this region; and the coal appears at the surface only where it has been thrust up through the overlying strata of red sandstone or where this sandstone has suffered very considerable denudation. As we were but six miles from the village where the murder occurred, the Mandarin sent to protect me declared he would not let me go on shore and inspect the mines on any condition, and therefore I could note only what was to be seen from the river as we passed. All the so-called "mines" that thus came in view were nothing more than deep pits in the sides of hills and consequently only "surface coals" have been obtained.

It is probable that the best coal occurs only below the water level, and the Chinese are obliged to stop when they come to that for want of proper pumping apparatus. In support of this view I may add that the engineers on the steamers at Hankow informed me that this coal had improved considerably since they first began to use it. The best coal in China therefore remains undisturbed, but there is much reason, in my opinion, to doubt whether it will ever equal the best coal in England and America. Hangchau is the great coal depot for the pro-

vince of Hunan, and the military Mandarin that accompanied me from that city to Changsha, the capital, stated that it is mined at Kweiyang and Laiyang (see Dr. Williams's map of China) and also at Sinhwa on the Tsz'kiang. It probably occurs almost everywhere beneath the red sandstone that covers the wide plains in the whole province, but it is only mined where it crops out along the borders of those plains.

From Lichang in Hunan to Moukden the capital of Manchuria, there is an almost continued series of coal mines on the flanks of the elevations that form the western border of the Great Plain. This wide distribution of coal promises much for the future development of this land.

The most important place for trade in Hunan is Siangtan, 90 li south of Changsha. All the boats that come down the numerous branches of the Siang make this their point of rendezvous, and there is water enough for small steamers from Hankow, unless a shallow bar occurs where this river empties into Tungting Lake. That place I crossed by night and therefore had no means of satisfying myself on that point. When I reached the lake a heavy northerly wind had been blowing for six or seven days and few or no boats had crossed it during that time. A southerly breeze then set in and all the boats that had been in the many creeks and bays came out on the lake, and at sunrise I enjoyed a view only to be witnessed in this land whose population is numbered by the hundred million. As far as the eye could see before us, behind us and for several miles on either side, the surface of the lake was perfectly feathered with white sails, some in sunshine, some in shadow and some in the dim distance, gliding on a thin film of air over the water. Twice during the day I counted nearly *four hundred and forty* in sight at one time; and with the aid of my field glass fully one hundred more could be distinguished. Many were loaded with tea, many with coal, and many were just swimming along under huge deck loads of round timber. This shows the amount of the carrying trade between Siangtan with Changsha; and Yohchau, and Hankow and other cities down the Yangtse. It also indicates that Siangtan is the most important place up the Yangtse that is not yet open to trade.

Below Yohchau a number of lakes occur, which Père Huc describes as abounding in floating islands, but I did not see *one*, and others who had passed to and fro over most of this area nformed me they had never heard of such a thing.

Oct. 5th. After sixty three days of continued traveling I at last reached Hankow—the distance by the route taken being about 1200 miles. For thirty-five days I had lived just as a common coolie, and frequently when we were waiting at the

cities for the Mandarins, I have laid in the bottom of my boat among the cargo with a straw mat over me without daring to stir for nearly half a day, for fear of a repetition of what occurred at Kweilin.

Once I had a severe attack of fever and ague, which seemed to set my brain on fire, and for fear I should lose command of my mind I gave my passport and money to my servant and ordered him to be sure to take care of me if I should become delirious, and to take me along with him to Hankow where my friends would reward him with an ample present. Fortunately, after suffering severely for a few days, I shook off the disease, encouraged by the idea that every hour was bringing me nearer the end of my weary journey. For the last fifteen days I did not once have an opportunity of leaving my boat and walking along the bank, the country was so completely submerged by a flood. The fever again began to burn in my veins but the exciting thought that soon I should be free from my persecutors sustained me until I found myself once more in the house of some American friends. All cause for solicitude was then over and for a week the doctor ordered me to keep my chamber.

This journey was undertaken with the hope of ascertaining the kinds of the rocks in the region traversed and the order of their superposition. The time chosen was the dry season, and admitted by all to be a *very* dry season. In such a coun try where no artificial sections can be seen, perhaps the river channels and the gorges in the mountains offer as good facilities as can be found, to ascertain the geological structure of a country. I therefore made my journey mostly in boats, which over a large portion of the area were the only means of traveling from place to place. It was only necessary to keep the boat near the bank and the strata could be seen and followed continously mile after mile, and when that series disappeared, those above it or below it could be studied in the same manner. In this way, from actual observation, the series was found to be: *First* and *lowest, granite;* on which rests the *second* formation composed of *grits and slates.* I am not aware that any fossils have ever been discovered in these rocks. These grits and slates are covered by the *third formation of old limestones,* which the fossils obtained at Sinchau lead us to regard as probably belonging to the Devonian age. On these rest, *fourthly,* another series of limestone strata of the same geological age as the coal beds. A rare collection of fossil plants of these rocks in the neighborhood of Peking was given me by l'Abbé David. They probably belong to the same geological age as the fossil plants sent by Mr. Pumpelly to Dr. Newberry, who regards them as later than the Carboniferous

period and probably Triassic. My journey through the great coal fields of Hunan also gave me an opportunity of more narrowly defining its limits. The route herein described was the one chosen for a railroad between Canton and the southern parts of the empire, and Hankow and the central parts of the country. But no one had been through the mountainous regions and ascertained whether there was a break in the Meiling Range or whether great tunneling would be necessary. Having passed over the whole area, I am prepared to say that there is no physical feature that would render the construction of such a road a work of any greater difficulty there than in a very hilly land. The great obstacles to such work in every part of China are, first, their bitter hostility to foreigners, and secondly, their superstitious fears that any such work "will affect the winds and rain and deluge their crops with floods or parch them with heat." The prevalence of this belief, and the extent to which it influences all their actions, are most surprising.

All over the empire are seen from place to place, deserted quarries of limestone and sandstone, and lead and other mines excepting coal. On inquiring why they do not continue to work in these places, the invariable reply has been "because it is forbidden by the Emperor." But in pressing this question farther I have found in every case except one that the Imperial edict has been made in this way. When a man commences an excavation, the neighboring community draw up a petition that this man be compelled to stop forthwith, that they may not lose their crops. This petition is handed to the Emperor, who not daring to oppose the will of the majority, in a most condescending manner says let the petition be granted. The work is then ended and thus the Emperor, while he plays the part of an absolute monarch, is really a supple slave. These facts therefore show that there is little or no inducement for either native or foreign capitalists to commence a railroad or any other such work in China until the government will not only give its consent, but also *can* and *will* guarantee to protect such property or fully make up any damage the people may do. When this can be done, it is as certain that railroads will pay there as that native and foreign merchants find it profitable now to use steamers on the Yangtse and Canton rivers and along the sea coast. Then, and not till then, will these great improvements be begun in China, and her future promise to be something more than a mere repetition of the past.

Up to the date of this journey it had been a matter of speculation whether there was a water communication between the river system of the Sikiang and that of the Yangtse. This

query is at once answered by the fact, that if the gentry of Kweilin and the people in the adjoining country had allowed me to proceed at my leisure and had not forced me to fly for my life, I could, even in that remarkably dry season, have performed the whole journey in boats except *nine* miles; and I am confident that if I had left Canton in the rainy season I could have made the whole distance of *two thousand miles*, through the interior of China, and come out to the sea coast again at Shanghai *in one and the same boat.*

This enables us to realize that the next wonder in regard to China, after the density of her population, is the completeness of her internal water communication.

ART. II.—*Preliminary notice of a Scorpion, a Eurypterus? and other fossils, from the Coal-measures of Illinois;* by F. B. MEEK and A. H. WORTHEN.

AMONGST some fossils discovered last summer by Mr. Joseph Even, in the iron nodules of the Coal-measures at Mazon creek, Grundy county, Illinois, and loaned by him for the use of the Illinois Geological Survey, there are a few types of such unusual interest, that we have thought it desirable to present a preliminary notice of them, in advance of more extended descriptions and illustrations, to appear in one of the reports of the Survey.

The first of these is a fine *Eurypterus*, or a species of a closely allied genus, between the size of *E. remipes* and *E. robustus*. The specimen consists of an impression in the matrix, of the under surface of all the thoracic, and a part of one or two of the abdominal segments, in a more or less nearly perfect condition; with the operculum or thoracic flap, the post-oral plate, and the maxillary or basal joints of the swimming feet, all in place. There are also prints of some of the succeeding joints of one of the latter organs, and its oar-like expansion, and obscure impressions of three of the smaller legs on one side, and some of the basal joints of the same on the other side *—all converging to the position of the mouth immediately in front of the post-oral plate. As the carapace and the dorsal portions of the thorax are enveloped in the other half of the concretion, which was not found, and the posterior portions of the abdomen and the telson extended beyond the limits of the concretion, we know nothing of the nature of any of these parts.

* These legs are slender, apparently without lateral spines, and terminate in a single long, acutely pointed dactylus, as in *Pterygotus*.

The post-oral plate is about 0·76 inch in length, and 0·55 inch in breadth, the widest part being very slightly behind the middle. Its general form is subovate. From near, or a little behind the middle, it rounds off rather rapidly to the rounded posterior end, and tapers more gradually to the anterior extremity, which is rounded on each side, and rather distinctly emarginate in the middle. The maxillary joints or plates of the swimming feet expose a subtrigonal outline—their length being 0·85 inch, and their breadth at the posterior margin about 0·70 inch. Their lateral slopes are slightly sinuous along the middle, while their anterior ends (or the portions exposed) are very narrow, pointed, curved inward, and extend scarcely beyond the anterior end of the post-oral plate. The succeeding joints are visible, but scarcely in a condition to be described.

The thorax measures 2·45 inches in breadth near the middle, and a little more than 2 inches in length. Its middle segments (on the ventral side) are 0·35 inch in length or anterio-posterior diameter, while the anterior and posterior ones, especially the latter, are shorter; and they are all rounded on their posterior lateral angles. Some impressions in the matrix, however, show that the lateral terminations of the *dorsal* portion of the posterior thoracic segments or rings extended out beyond the rounded ends of those below into acutely pointed extremities, directed obliquely outward and backward. These projecting points of one of the posterior thoracic segments are seen to extend out obliquely 0·46 inch beyond the rounded terminations of those below, and to terminate in very acute points. A portion of one of the anterior abdominal segments remaining, if not accidentally slipped a little to one side, shows that the abdomen is comparatively narrow, and that its segments have the posterior lateral extremities terminating in strong angular processes, nearly straight behind, but with an oblique anterior margin.

The operculum, or thoracic flap, has its lateral alæ, as in the typical species of *Eurypterus*, looking as if composed of two of the body segments anchylosed, the anterior one being not more than half the breadth (more properly length) of the other, which is of the same size as the body segments.* Its mesial appendage is remarkably long, as it can be traced back beyond the poste-

* These alæ in *E. remipes*, and other Silurian species, resemble body segments so closely that they were actually mistaken by Prof. Hall, for "anchylosed first and second segments of the body" (Palæont. N. Y. vol. 3, p. 398, fig. 3, 1 and 2), and not suspected by him to be homologous with any part of the free operculum itself, of the genus *Limulus*. This error has been pointed out and corrected by Mr. Woodward, in his memoir on the genus *Pterygotus*, published by the Paleontographical Society, pp. 40 and 41—1866.

rior margin of the fifth thoracic segment, or to a length of 1·60 inches, while we are almost positively sure it is not bipartite at the extremity. There is also on each side of the anterior, or attached extremity of the mesial appendage, a small spatulate piece, not corresponding to any of the parts of the operculum of *Eurypterus*, as hitherto illustrated, so far as we have yet seen. These are about 0·41 inch in length, and 0·15 inch in breadth, with nearly parallel sides and pointed anterior extremities, while their posterior ends are transversely truncated, with lateral angles rounded. Their anterior pointed ends terminate nearly in contact with the posterior angles of the two little "intercalated pieces" (*a a*) of Prof. Hall's fig. 3, p. 398, of third vol. Palæont. N. Y.; so that they occupy exactly the position of what are apparently intended in that figure to represent the inner truncated ends of the lateral alæ, immediately on each side of the mesial appendage. They are proportionally wider, however, and extend back slightly beyond the posterior margins of the lateral alæ, and are certainly separate pieces. They were evidently over-lapped, on their inner edges at least, by the mesial appendage, and look as if, in case they were attached at all to the operculum, it must have been to its inner side. Possibly, however, they were really attached to the anterior thoracic segment, and form no part of the operculum itself; in which case they would seem to represent, though greatly smaller, the membranaceous modified feet of Limulus, bearing the branchiæ. As now seen, however, in the condition of impressions, they certainly look as if appendages of the operculum; while they show the same scaly sculpturing seen on other parts of the surface.

All the portions of the under side of the fossil, that have left their impressions in the matrix, were provided with fine subimbricating scale-like markings.

From some of the characters mentioned, particularly the great length and non-bipartite extremity of the mesial appendage of the operculum, and the presence of the two additional spatulate appendages, one on each side of the mesial one, we are very much inclined to believe other characters will be found, separating this species generically, or at least subgenerically, from the typical *Eurypteri*. If so, it may be called *Anthraconectes*. For the present, however, we would designate it as *Eurypterus* (*Anthraconectes*) *Mazonensis*.

It is worthy of note here, that Jordan and von Meyer have proposed the name *Adelopthalmus*, for a type from the Coal-measures of Bohemia, very similar to *Eurypterus*, but differing in having no eyes, at least in the position they occupy in *Eurypterus*; while it also differs in having the lateral extremities

of the dorsal half of each thoracic segment more pointed and projecting apparently farther beyond those below. As our fossil shows the latter character (but with these projecting extremities much more acutely angular), as well as the same sudden contraction in the breadth of the body, behind the sixth or seventh segment, it is barely possible it may be found to belong to the same group, and have to take the name *Adelopthalmus Mazonensis*. As their type, however, shows only the *upper* side, and ours the impression of the *lower* only, we have not the means of settling this question at present.

Another specimen, from the black shale of the Coal-measures of Grundy county, near the Mazon creek locality, but from apparently a little higher horizon, has exactly the form and appearance of one side of the carapace of a large *Ceratiocaris;* to which genus we would have no hesitation in referring it, were it not for its rather solid shelly texture, non-striate surface, and the fact that that genus has not hitherto, we believe, been found in the Carboniferous rocks. It is quite thin, however, of an irregular rhombic subovate form, and nearly as large as *C. acuminatus* (3d vol. N. Y. Palæont. pl. 84, fig. 6), which it resembles in general outline, excepting that its truncated posterior margin is so deeply sinuous as to leave the posterior dorsal extremity above the sinus (as well as that below) rather acutely angular; while its anterior extremity, above the obliquely truncated antero-ventral margin, is obtuse instead of pointed. Its basal margin is also more prominent slightly behind the middle. The surface shows no striæ, or other markings, and the margins are smoothly and sharply defined; that of its posterior sinuous edge being also neatly beveled. It may be called *Ceratiocaris? sinuatus.*

Length, 3·36 inch; height, 2·75 inch.

The specimen of the scorpion alluded to at the head of this notice, consists of a cast and mould of the fossil, as revealed in splitting open a concretion; and shows most of the cephalothorax and mandibles, in a somewhat crushed condition, the dorsal side of the seven abdominal segments, and three of those of the tail, all in place:—also four of the legs on one side, and one of the peculiar comb-like organs, characteristic of the family *Scorpionidæ*, detached and lying in the matrix near one side of the abdomen.

The cephalothorax seems to be sub-quadrangular in form, somewhat wider (behind) than long, the breadth being about 0·45 inch. Unfortunately it is not in a condition to show the ocelli, nor can we see whether or not its anterior edge is emarginate. Its posterior edge has a very slender, minutely crenate, raised marginal line, from a little in advance of which

there originates a distinct mesial furrow, that extends forward to near the middle of the shield, where it is intersected by two oblique furrows, with the prominence for the mesial ocelli between them. Two other deep lateral furrows extend, one on each side, from the posterior end of the mesial one, obliquely outward near the posterior margin. The surface is ornamented with irregular scattering granules, mostly upon the prominences between the furrows. The mandibles are very stout, with the structure of those of the true *Scorpionidæ*, and seem to be without distinct teeth; movable finger curved and sharp at the point. Palpi unknown. Legs stout, long, with long joints gradually decreasing in breadth, and apparently like all the other parts, without hairs, serrations or spines.

The abdomen is a little more than twice the apparent length of the cephalothorax, or about 0·90 in. in length and 0·60 in. wide, and has its segments (on the dorsal side) gradually increasing in their antero-posterior diameter backward to the sixth one, the anterior one being narrowest in the middle, in consequence of the broadly sinuous character of its anterior margin; the first, second and sixth ones have their latter extremities rounded,—the third, fourth and fifth have them rounded in front, and nearly rectangular behind. The seventh or last abdominal segment is twice and a half as long as the sixth or longest of the others (being 0·35 inch long and 0·48 in breadth), subtrigonal in form, with the posterior angle broadly truncated for the attachment of the tail, and the anterior lateral angles narrowly rounded. They all have the surface a little granular, the granules being very small and arranged along near the posterior margins. The last one also shows, on the posterior half of the middle, two longitudinal, parallel rows of rather crowded minute punctures.

Of the tail, only the anterior three segments are preserved in the specimen. These show that it was rather stout, but as distinct from the abdomen, by its sudden contraction in breadth, and the form of its segments, as in the living examples of the *Scorpionidæ*. It segments measure as follows:—first one, 0·26 inch in length and 0·24 in breadth; second, 0·34 in length and 0·22 in breadth; third, 0·37 in length and 0·18 in breadth. They are all oblong in form, more or less nearly rectangular at their ends, and, as near as can be determined from a flattened specimen, apparently provided with three longitudinal ridges, with scattering granules above.

The single detached comb-like organ seen lying in the matrix on one side of the abdomen shows eleven of the little bars of division, but is incomplete at both ends.

Although the discovery of such a type in our Coal-measures, even in the mutilated condition of this specimen, is one of much interest, it is still greatly to be regretted, that its condition is such as to show no traces of the ocelli, neither mesial nor lateral, nor of the palpi and terminal portions of the tail,—since these, especially the ocelli, are the very parts upon which generic distinctions are based by most of the naturalists who have investigated the living Scorpions. Consequently, we are left entirely without the means of deciding which of the known genera it would fall into, if not a new generic type. Its general physiognomy, however, the structure of its mandibles, and particularly the possession of the peculiar comb-like organs, leave no doubt whatever in regard to its belonging to the family *Scorpionidæ*, as defined by the generality of authors.

On comparison with the only other Scorpion known to us from the Carboniferous System—(*Cyclopthalmus Sternbergi* from the Coal-measures of Bohemia)—it will be found to differ remarkably in having its tail as distinct from the abdomen, in form and breadth, as in the modern Scorpions (with which it agrees exactly in general appearance, so far as its parts are yet known), instead of having its abdomen passing imperceptibly into the tail, without any well defined change in the form of the segments.

Although our specimen does not retain the anterior part of the cephalothorax, and therefore shows no traces of the eyes, it is evident they could not have been arranged in a large circle around the central prominence for the mesial pair, as in *Cyclopthalmus*, since the posterior two-thirds of the cephalothorax is well preserved, and would include more than half of the circle of eyes if they were arranged as in that genus.

A comparison with recent Scorpions leads us to think it most nearly resembles, in general appearance, the group of species generally referred to Leach's genus *Buthus*. In size, form, and particularly in the ridges and furrows of the *cephalothorax*, and the stoutness of its tail, it resembles *Buthus hirsutus*, of Wood, from California. From these points of general resemblance, and the necessity for some name by which the fossil can be conveniently referred to, we would propose to designate it provisionally, until specimens can be found showing the generic characters, as *Buthus ? ? carbonarius*. In the meantime, those who, like Gervais and others, do not admit the modern subdivisions of the Linnæan genus *Scorpio*, can, in a general way, call it *Scorpio carbonarius*.

That it will be found strictly identical with any modern genus, however, when all its characters can be made out, is exceedingly improbable ; and we are prepared to believe more

nearly perfect specimens will show it to be typical of a new genus. If so, it might be called *Eoscorpius*, in allusion to its early appearance in time.

Amongst the specimens we have, from time to time, had an opportunity to examine from the Mazon creek locality, we have frequently observed impressions of a long, many jointed fossil, in regard to the true nature of which we have been unable to arrive at any very satisfactory conclusion. We could hardly doubt but it was an Articulate of some kind, and were inclined to believe it a Myriapod. All our examinations, however, of the specimens at that time known, failed to quite satisfy us that what looked like legs projecting out into the matrix, were really not rigid, inarticulate spines.* Hence, we were left in some doubt, whether or not it might be the mould of the vertebral column of some little vertebrate animal; and after many careful examinations, we concluded to lay the specimens aside, hoping that better examples might be found, giving some clue to their nature. In the meantime, however, we showed all of them we had seen to several of our most eminent naturalists, none of whom could give us any suggestions in regard to the affinities of the animal.

Several of the specimens now before us, of this same fossil, found last summer by Mr. Even at the same locality, are more complete, in some respect, than any we had previously seen; and from these we are satisfied that it is not a vertebral column, but really an articulated animal. As it seems impossible that it can be a Crustacean, an Annelid, or larval insect, we can scarcely doubt that it is a gigantic *Myriapod.*

One of the specimens now before us seems to be entire, and has apparently a sub-hemispherical head, as wide as any part of the long slender body. It is not in a condition to show the eyes, if any existed, nor can we see any remains of mandibles, antennæ, or other appendages connected with it. The entire length of this specimen is 3·90 inches, and its breadth about 0·20 inch. It tapers very little from the anterior to the posterior end, which terminates rather abruptly. In the whole length, as many as seventy-five or seventy-six segments can be counted; but it is worthy of note, that there are only *half this number* on the dorsal side, where each one corresponds to two below.† As seen in a side view, the downward curved ends of the dorsal scutes, if we may so call the larger dorsal portions of the segments, are rounded in outline; while each of them

* At that time, we had only seen specimens showing the dorsal spines distinctly, and no well preserved legs.

† This peculiarity of the segments of the body occurs in some types of existing *Myriapoda.* (Family *Cermatiidæ*, in which the dorsal scutes are also generally spiniferous.)

bears apparently three or four short, pointed, rigid spines, directed obliquely backward, and arranged so as to form as many longitudinal rows along the back and dorso-lateral parts of the animal. Some of these spines are seen to give off a small, short, lateral fork, or branch, on the anterior or posterior side.

On the under side of the body there are, as already stated, two segments, or rather two half rings of the dermal integument, to each one above, and these of course are scarcely half the size of those above, though each bears a pair of small slender jointed legs, about 0·20 inch in length, in the specimen nearly 4 inches long. So far as can be made out, there are at least five gradually tapering joints to each leg. In some of the specimens these lower segments show appearances of something like spiracles, though we are not sure that they are such. For a long time we failed to detect joints in the legs, but in some of the specimens now before us they can be clearly seen.

Under a magnifier, the impressions of the body rings in the matrix show a minutely granular kind of marking, that must have been produced by minute pitting of the surface. No hairs, however, have been seen projecting from any part of the fossil.

For this uncouth looking creature, we would propose the generic name *Euphoberia*, in allusion to the formidable appearance a living example, more than a foot in length, must have presented, when alive and moving about, with its back bristling with forked spines, and its 150 legs in motion. Some fragments in the collection are much larger than the most complete specimen from which our measurements are given, and if of the same proportions, the individuals to which they belonged must have been from 12 to 15 inches in length, and near ‡ of an inch in diameter. The specimens seem to belong to two species, one comparatively small, and one large. For the smaller typical one, from which the foregoing description was made out, we would propose the name *E. armigera*, and for the larger *E. major*.*

On comparing our specimens with a curious jointed, spiniferous fossil, figured and described by Mr. Salter in the Quarterly Journal of the Geological Society of London, vol. xix., p. 84, fig. 8, from the Staffordshire Coal-measures, under the name *Eurypterus?* (*Arthropleura*) *ferox*, we can scarcely entertain

* Jordan and von Meyer have proposed the name *Chonionotus* (see Palæontographica, vol. 4, 1856, pl. 11, fig. 3) for a fragment of a jointed fossil, from the Coal-measures, that may *possibly* belong to the *under* side of a species of this genus, though it is not very probable that it does. If it does, however, our generic name would have to be abandoned, and the name of our species would become *Chonionotus armiger*, and *C. major*.

a doubt of their generic identity. Indeed, if it were not that his species has the dorso-lateral spines each provided with three instead of two prongs, and proportionally longer, it would be difficult to point out even specific differences. His specimen consists merely of the dorsal side of six of the segments preserving the dorso-lateral rows of spines, and two dorsal rows of tubercles, which we are inclined to think must have also borne spines. Mr. Salter thought it probably a part of the central lobe of a trilobate *Eurypterus*, or some allied genus, an opinion he would not for a moment have entertained (provided we are right in regard to its relations to our fossil) had he seen a specimen showing a side view of even a few segments of the animal. At any rate, our fossil is entirely distinct, in all respects, from the typical species of *Arthropleura* of Jordan and von Meyer, which is almost certainly a Crustacean.

Supplementary Note on some of the Morris Crustacea, &c., formerly described.

A number of additional specimens now before us, in various conditions of preservation, of some of the articulates already described and figured in the Illinois State Geological Report, from the Grundy county locality, enable us to add some facts in regard to these fossils not determinable from the specimens first obtained. This additional information we give below:—

1. Genus *Acanthotelson.* It is a little remarkable, that all the specimens of the two known species of this genus, at first obtained, lie flattened in the concretions on *one side* or the other, as shown in our figures. The fact that so many individuals had been thus found, and none enveloped as if standing with the thoracic legs spread out on each side for walking, led us to think the former probably their natural posture, and that like the typical *Amphipoda*, they might not have had the power of standing upon their legs. Several of those more recently obtained, however, are enveloped in such a manner, that in splitting open the concretions in the plane of their greatest (horizontal) diameter, we have exposed a dorsal view of the fossil, with its thoracic legs extended out on each side, so as to show that the animal could probably stand and walk upon them, and that this may have been its natural attitude. It is also worthy of note, that in all these specimens, the thoracic legs are *all* directed forward, and not a part of them forward and a part backward, as in most of the *Amphipoda.*

These specimens also clearly show that the last joint of each stylet is, as we had conjectured, bipartite, the two terminal

pieces of each being exactly alike, and scarcely distinguishable in size and form from the telson. They likewise appear to show that the stylets do not, as we had supposed, connect with the same segment as the telson, but probably with the next one in advance of it, and that both the stylets and telson are horizontally flattened. Our outline restorations of these parts in this type, on the plate cited, would be corrected, if this suggestion is right, by marking off a short inconspicuous segment, from the anterior end of the telson, as now represented.

One specimen of apparently a new species, nearly allied to *A. Stimpsoni*, has the peduncles of the outer antennæ well preserved, and shows them to be stout, and composed of three joints. Its body is proportionally about one-fourth longer than that of *A. Stimpsoni*, with proportionally larger anterior legs. As seen on the dorsal side, its body is long, narrow and rounded, with parallel sides, excepting a few of the posterior segment, which gradually taper to the telson. For this larger, more elongate species, we would propose the name *A. Eveni*, after Mr. Joseph Even of Morris, who has discovered most of these interesting fossils.

Several of the specimens show that none of the thoracic legs of this genus bifurcate as in the genus *Gampsonyx*.

2. Genus *Palæocaris*. We are now nearly satisfied, from additional specimens, that the caudal appendages and jointed body represented by our figure 5*a*, pl. 32, of the Illinois Report, really belong to the same species as the specimen represented by figure 5 of the same plate, as we had supposed.

Since we now know that in *Acanthotelson* the stylets and telson are horizontally flattened, and that the animal had its legs constructed for walking, and, like its antennæ, very similar to those of the type of *Palæocaris*, we think these types more nearly allied to each other, and to *Gampsonyx*, in some characters, than we had supposed, but still quite distinct from the latter type, in not having the legs divided, and in the different characters of their telson and stylets. We hope to be able to illustrate all these points by figures, before long.

Genus *Anthracerpes*. As no fragments of this fossil have been obtained showing any legs, we are inclined to the opinion that it may be an Annelid.

ART. III.—*On the formation of Nitrite of Ammonia;* by O. LOEW, Assistant in the Chemical Department of City College, New York.

MANY years ago, Liebig showed that alloxan, the immediate product of the oxydation of uric acid, yields with ammonia, a substance of a bright red color, murexyd. Ammonia has therefore been used for many years as a good reagent for alloxan, and for uric acid. Of course, therefore, alloxan can be also employed as a good reagent for ammonia; extremely small traces of ammonia indeed, can be found in this way, if necessary precautions be used. In order to have alloxan in a convenient form as a reagent, I dipped strips of Swedish filter-paper in a solution of alloxan and dried them in vacuo, after having put them into dried ether. In preparing the paper at first, I employed for drying it, the water-bath; but always, before it was perfectly dried, it became red. Afterward I dried it in a bell-jar over sulphuric acid; but here *too* remarked, that the ends of the strips became red. This appearance seemed to me extremely singular and remarkable. All the glass vessels, that I used, were perfectly clean; the air in the bell-jar could not possibly contain ammonia, by reason of the contact with the sulphuric acid; and on the other hand I was sure, that the bell-jar was well closed, so that it was impossible for a trace of ammonia gas to enter from the outside. I repeated this experiment in a modified manner, namely:—I put some milligrammes of alloxan in a test-tube and poured some drops of water on them (distilled water I avoided because of its containing ammonia) and placed some strips of Swedish filter paper in the test-tube in such a way that the lower ends dipped into the above mentioned solution of alloxan, and the upper ends projected a little above the mouth of the tube. The test-tube was then set upright in a bottle (for support), and both were placed in a vessel containing sulphuric acid and standing on a glass plate. A bell-jar was put over the whole, taking care that the junction was air-tight. The apparatus was then set in a place where ammonia had never been used. Next day the tips of the projecting ends began to turn red, and the redness increased, until the last trace of water was evaporated out of the test-tube. I made this experiment the third time, taking care as before, that the vessels I used were perfectly clean. The bell-jar and test tube were washed with diluted sulphuric acid, afterward with alcohol, the strips were not touched with the fingers, only a pincers was em-

ployed. At first I did not remark any reddening, but it became visible in an extremely short time, when the apparatus was placed in the sunlight. I repeated this experiment more than once and always found, that—1, this red color appears only at that part of the paper where the evaporation of the water takes place. 2. This discoloration does not increase after all the water is evaporated and absorbed by the sulphuric acid. 3. This phenomenon makes its appearance very quickly in the sunlight, and slowly in diffused daylight.

Now what are the reasons of this phenomenon? Only one explanation suggests itself, and that is given by the discovery of Schoenbein, in regard to the formation of nitrite of ammonia from water and nitrogen. There can be no doubt that this coloration only comes from the nitrite of ammonia, formed by the evaporation of such a small quantity of water. The open end of the test-tube was in contact with the dried air in the bell-jar; therefore, the upper ends of the strips projecting out of the tube were the chief seat of evaporation. The lower ends sucked up the same amount of water as the upper lost. Thus a considerable amount of water evaporated from a very limited space; the generated nitrite of ammonia was therefore also limited to this space, and on the other hand, the solution of alloxan became concentrated here also, forming a crystalline surface on the ends of the paper. In the ordinary evaporation of water, the newly formed nitrite of ammonia is quickly destroyed again, generating water and nitrogen:— $\left.\begin{matrix}NH_4\\NO\end{matrix}\right\}O=$ $2H_2O+2N$ (O=16.) But in our case every trace of this salt is quickly fixed by the alloxan, murexyd being formed, which is the cause of this reddening. If one employs a concentrated solution of alloxan, the experiment will not always succeed, because the crystalline surface formed by it will not allow the water to be sucked up, and therefore the place of evaporation changes. On the other hand, the ammonia salt thus formed is mixed with a large amount of alloxan, so that the phenomenon does not become so readily visible. That not only free ammonia can produce murexyd, but also the nitrite, I have proved; many other ammonia salts produce this color, with alloxan. One sees from this experiment that doubtless every drop of water by its evaporation yields a certain quantity of nitrite of ammonia, and further that the direct sunlight accelerates in a great degree this formation. If we consider the amount of carbonic acid and ammonia in the atmosphere, we find the proportion of C : N=300 : 1 (N in the form of ammonia), but if we compare with that, the proportion of these two elements in the body of vegetables, we find on an average

the ratio of 50 : 1. Whence then comes the nitrogen that is required to make up the proper proportion? The ammonia of the soil is not able to give a sufficient answer to this question, but we have here the explanation: *In the direct sunlight, not only the carbon and hydrogen are taken up in a higher degree, but also the nitrogen of the air, the latter being quickly converted into the easily assimilable form of nitrite of ammonia.*

New York, April 1, 1868.

ART. IV.—*Notes on some Algæ from a Californian hot Spring;* by Dr. H. C. WOOD, Jr., Professor of Botany in the University of Pennsylvania.

SOME time since Prof. Leidy handed me for examination a number of dried Algæ, which he had received from Prof. Seidensticker, by whose sister, Mrs. Partz, they had been gathered in the "Benton Spring," which is situated in the extreme northern point of Owen's Valley, California, 60 miles southwest from the town of Aurora. Afterward a number of similar specimens came to me directly from Mrs. Partz by mail. The subject of life in thermal springs is one of so much general interest, especially in connection with that of spontaneous generation, as to induce me to make a very careful examination of the material and offer the results to the readers of this Journal. In this connection the following extract from a letter of Mrs. Partz to her brother is very relevant:

"I send you a few samples of the singular vegetation developed in the hot springs of our valley. These springs rise from the earth in an area of about 80 square feet, which forms a basin or pond that pours its hot waters into a narrow creek. In the basin are produced the first forms, partly at a temperature 124°–135° F. Gradually in the creek and to a distance of 100 yards from the springs are developed at a temperature of 110°–120° F. the Algæ, some growing to a length of over 2 feet, and looking like bunches of waving hair of the most beautiful green. Below 100° F. these plants cease to grow and give way to a slimy fungus growth, though likewise of a beautiful green, which finally, as the temperature of the water decreases, also disappears. They are very difficult to preserve, being of so soft and pulpy nature as not to bear the least handling, and must be carried in their native hot water to the house, very few at a time, and floated upon paper. After being taken from the water and allowed to cool they become a black pulpy mass. But more strange than the vegetable are the animal organiza-

tions, whose germs, probably through modifications of successive generations, have finally become indigenous to these strange precincts. Mr. Partz and myself saw in the clear waters of the basin a very sprightly spider-like creature running nimbly over the ground, where the water was 124° F., and on another occasion dipped out two tiny red worms."

In regard to the temperatures given and the observations as to the presence of animal life in the thermal waters, Mr. Wm. Gabb of the State Geological Survey states that he has visited the locality, knows Mrs. Partz very well, and that whatever she says may be relied on as accurate.

The color of the dried specimens varies from a very elegant bluish green to a dirty greenish and fuscous brown. After somewhat prolonged soaking, in hot water, the specimens regained apparently their original form and dimensions, and were found to be in very good condition for microscopical study.

The plant in its earliest stages appears to consist simply of cylindrical filaments, which are so small that they are resolved, with some difficulty, into their component cells by a first class $\frac{1}{5}$th objective. Fronds composed entirely of filaments of this description were received. Some of these were marked as "first forms," and as having grown in water at a temperature of 160° F. Probably these were collected immediately over the spot where the heated water bubbled up. At this temperature, if the collection made is to be relied on as a means of judging, the plant does not perfect itself. To the naked eye these "first forms" were simply membranous expansions of a vivid green color, and indefinite size and shape, scarcely as thick as writing paper, with their edges very deeply cut and running out into a long waving hair-like fringe. Other specimens which grew at a much lower temperature exactly simulated those just described, both in general appearance and microscopical characters.

These I believe are the immature plant.

The matured fronds, as obtained by the method of soaking above described, were "gelatinous-membranous," of a dirty greenish or fuscous brown at their bases and bright green at their marginal portions, where they were deeply incised and finally split up into innumerable hair-like processes. Proximally they were one or even two lines in thickness, distally they were scarcely as thick as tissue paper. Their bases were especially gelatinous, sometimes somewhat translucent, and under the microscope were found to have in them only a few distant filaments.

Two sets of filaments were very readily distinguished in the adult plant. The most abundant of these, and that especially

found in the distal portions of the fronds, were composed of uniform cylindrical cells, often enclosed in a gelatinous sheath. The diameter of such filaments varies greatly; in the larger the sheaths are generally apparent, in the smaller they are frequently indistinguishable.

In certain places these filaments run more or less parallel side by side, and are glued together into a sort of membrane. It is only in these cylindrical filaments that I have been able to detect heterocysts, which are not very different from the other cells. They are about one-third or one-half broader, and are not vesicular but have contents similar to those of the other cells. In one instance only was I able to detect hairs upon these heterocysts.

The larger filaments are found especially near the base and in the other older portions of the frond. Their cells are generally irregularly elliptical or globose, rarely are they cylindrical.

They are mostly of an orange brown color, and there exists a particular gelatinous coating to each cell rather than a common gelatinous sheath to the filament. These larger threads are apparently produced from the smaller filaments by a process of growth.

Near the base and in the under portions of the fronds, these filaments are scattered in the homogeneous jelly, in which they run infinitely diverse courses. In the upper portions of the frond and at some little distance from the base, the adjoining cells are very close to one another and pursue more or less parallel courses, with enough firm jelly between to unite them into a sort of membrane.

This plant certainly belongs to the Nostochaceæ, and seems a sort of connecting link between the genera Hormosiphon of Kützing and Nostoc.

The best algologists now refuse to recognize the former group as generically distinct, and the characters presented by this plant seem to corroborate that view.

The species appears to be an undescribed one, and I would propose for it the specific name *Caladarium*, which is suggested by its place of growth. There are several species of allied genera, which grow in the hot springs of Europe, but no true Nostoc has, I believe, before been found in thermal waters. The following is the technical description of the species:

N. caladarium, sp. nov.—N. thallo maximo, indefinite expanso, aut membranaceo-coriaceo vel membranaceo-gelatinoso vel membranaceo, aut læte viride vel sordide olivaceo-viride vel olivaceo-brunneo, irregulariter profunde laciniato-sinuato, ultimo eleganter laciniato; trichomatibus inæqualibus, inter-

dum flexuoso-curvatis, plerumque subrectis et arcte conjunctis, in formis duabus occurrentibus; forma altera parve, viride, articulis cylindricis, cum cellulis perdurantibus hic illic interjectis, vaginis interdum obsoletis, sæpius diffluentibus, instructa; forma altera maxima, articulis globosis vel oblongis, aurantiaco-brunneis, cellulis perdurantibus ab ceteris haud diversis.

Diam. Cellulæ cylindricæ maximæ $\frac{1}{1000}$ unc. Cellulæ perdurantes $\frac{1}{600}$ unc.

Diam. Formæ primæ articuli maximi $\frac{1}{1000}$ unc. Cellulæ perdurantes $\frac{1}{600}$ unc. Formæ secundæ articuli oblongi longi $\frac{1}{2000}$–$\frac{1}{3000}$ unc., lati $\frac{1}{3000}$–$\frac{1}{5000}$, articuli globosi $\frac{1}{3500}$–$\frac{1}{4000}$ unc.

Adherent to, and often more or less imbedded in, the fronds of the Nostoc, were scattered frustules of several species of diatoms, none of which was I able to identify. In some of the fronds there were numerous unicellular Algæ, all of them representatives of a single species belonging to the genus *Chroococcus Nägeli*. This genus contains the very lowest known organisms—simple cells without nuclei, multiplying, as far as known, only by cell division. These cells are found single or associated in small families, and in certain species these families are united to form a sort of indeterminate gelatinous stratum. In this species the families are composed of but very few cells, surrounded by a very large, more or less globular or elliptical mass of transparent, firm jelly. The species is very closely allied to *Chroococcus turgidus*, var. *thermalis* Rabenh, from which it differs in the outer jelly not being lamellated.

The following is the technical description of the species:

C. thermophilus, sp. nov.—Ch. cellulis singulis, aut geminis vel quadrigeminis et in familias consociatis, oblongis vel subglobosis, interdum angulosis, haud strato mucoso formantibus; tegumento crassissimo, achroo, haud lamelloso, homogeneo; cytioplasmate viride, interdum subtiliter granulato, interdum homogeneo.

Diam. Cellulæ singulæ sine tegumento longitudo maxima $\frac{1}{1500}''$, latitudo maxima $\frac{1}{2500}''$.

Art. VI.—*On Faraday as a Discoverer;* by John Tyndall, F.R.S.*

Parentage: Introduction to the Royal Institution: Earliest Experiments: First Royal Society Paper: Marriage.

It has been thought desirable to give you and the world some image of Michael Faraday, as a scientific investigator and discoverer. The attempt to respond to this desire has

* From the Report of the Royal Institution of Great Britain.

been to me a labor of difficulty, if also a labor of love. For however well acquainted I may be with the researches and discoveries of that great master,—however numerous the illustrations which occur to me of the loftiness of Faraday's character and the beauty of his life,—still to grasp him and his researches as a whole; to seize upon the ideas which guided him, and connected them; to gain entrance into that strong and active brain, and read from it the riddle of the world—this is a work not easy of performance, and all but impossible amid the distraction of duties of another kind. That I should at one period or another speak to you regarding Faraday and his work, is natural, if not inevitable; but I did not expect to be called upon to speak so soon. Still the bare suggestion that this is the fit and proper time for speech sent me immediately to my task: from it I have returned with such results as I could gather, and also with the wish that those results were more worthy than they are of the greatness of my theme.

It is not my intention to lay before you a *life* of Faraday in the ordinary acceptation of the term. The duty I have to perform is to give you some notion of what he has done in the world; dwelling incidentally on the spirit in which his work was executed, and introducing such personal traits as may be necessary to the completion of your picture of the *philosopher*, though by no means adequate to give you a complete idea of the *man*.

The newspapers have already informed you that Michael Faraday was born at Newington Butts, on the 22nd of September, 1791, and that he fell finally asleep at Hampton Court, on the 25th of August, 1867. Believing as I do, in the general truth of the doctrine of hereditary transmission—sharing the opinion of Mr. Carlyle that "a really able man never proceeded from entirely stupid parents"—I once used the privilege of my intimacy with Mr. Faraday to ask him whether his parents showed any signs of unusual ability. He could remember none. His father, I believe, was a great sufferer during the latter years of his life, and this might have masked whatever intellectual power he possessed. When thirteen years old, that is to say in 1804, Faraday was apprenticed to a bookseller and bookbinder in Blandford street, Manchester-square: here he spent eight years of his life, after which he worked as a journeyman elsewhere.

You have also heard the account of Faraday's first contact with the Royal Institution: that he was introduced by one of the members to Sir Humphry Davy's last lectures; that he took notes of those lectures, wrote them fairly out, and sent them to Davy, entreating him at the same time to enable him

to quit trade, which he detested, and to pursue science, which he loved. Davy was helpful to the young man, and this should never be forgotten: he at once wrote to Faraday, and afterward, when an opportunity occurred, made him his assistant.* Mr. Gassiot has lately favored me with the following reminiscence of this time:—

"CLAPHAM COMMON, SURREY,
"*28th November*, 1867.

"*My dear Tyndall*,—Sir H. Davy was accustomed to call on the late Mr. Pepys in the Poultry on his way to the London Institution, of which Pepys was one of the original managers; the latter told me that on one occasion, Sir H. Davy, showing him a letter said, 'Pepys, what am I *to do*, here is a letter from a young man named Faraday; he has been attending my lectures and wants me to give him employment at the Royal Institution, *what can I do?*' '*Do*,' replied Pepys, 'put him to wash bottles; if he is good for anything, he will do it directly; if he refuses, he is good for nothing.' 'No, no,' replied Davy; 'we must try him with something better than that.' The result was, that Davy engaged him to assist in the Laboratory at *weekly* wages.

"Davy held the joint office of Professor of Chemistry, and Director of the Laboratory; he ultimately gave up the former to the late Professor Brande, but he insisted that Faraday should be appointed Director of the Laboratory, and, as Faraday told me, this enabled him on subsequent occasions to hold a definite position in the Institution, in which he was always supported by Davy. I believe he held that office to the last.

"Believe me, my dear Tyndall, yours truly,
"Dr. Tyndall." "J. P. GASSIOT.

From a letter written by Faraday himself soon after his appointment as Davy's assistant, I extract the following account of his introduction to the Royal Institution:—

"LONDON, *Sept. 13th*, 1813.

"As for myself I am absent (from home) nearly day and night except occasional calls, and it is likely shall shortly be absent entirely, but this (having nothing more to say and at the request of my mother) I will explain to you. I was formerly a bookseller

* Here is Davy's recommendation of Faraday, presented to the managers of the Royal Institution, at a meeting on the 18th of March, 1813, Charles Hatchett, Esq., in the chair:—

"Sir Humphry Davy has the honor to inform the managers that he has found a person who is desirous to occupy the situation in the Institution lately filled by William Payne. His name is Michael Faraday. He is a youth of twenty-two years of age. As far as Sir H. Davy has been able to observe or ascertain, he appears well fitted for the situation. His habits seem good; his disposition active and cheerful, and his manner intelligent. He is willing to engage himself on the same terms as given to Mr. Payne at the time of quitting the Institution.

"*Resolved*,—That Michael Faraday be engaged to fill the situation lately occupied by Mr. Payne, on the same terms."

and binder, but am now turned philosopher,* which happened thus:—Whilst an apprentice, I, for amusement, learnt a little chemistry and other parts of philosophy, and felt an eager desire to proceed in that way further. After being a journeyman for six months under a disagreeable master, I gave up my buisness, and through the interest of a Sir H. Davy, filled the situation of chemical assistant to the Royal Institution of Great Britain, in which office I now remain; and where I am constantly employed in observing the works of nature, and tracing the manner in which she directs the order and arrangement of the world. I have lately had proposals made to me by Sir Humphry Davy, to accompany him in his travels through Europe and Asia as philosophical assistant. If I go at all I expect it will be in October next—about the end, and my absence from home will perhaps be as long as three years. But as yet all is uncertain."

This account is supplemented by the following letter, written by Faraday to his friend De la Rive,† on the occasion of the death of Mrs. Marcet. The letter is dated 2d Sept., 1858:

"*My dear Friend*,—Your subject interested me deeply every way; for Mrs. Marcet was a good friend to me, as she must have been to many of the human race. I entered the shop of a bookseller and bookbinder at the age of 13, in the year 1804, remained there eight years, and during the chief part of the time bound books. Now it was in those books, in the hours after work, that I found the beginning of my philosophy. There were two that especially helped me, the 'Encyclopædia Britannica,' from which I gained my first notions of electricity, and Mrs. Marcet's 'Conversations on Chemistry,' which gave me my foundation in that science. . . . . .

"Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively, imaginative person, and could believe in the 'Arabian Nights' as easily as in the 'Encyclopædia.' But facts were important to me, and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs. Marcet—first, as one who had conferred great personal good and pleasure on me; and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things, to the young, untaught, and inquiring mind.

"You may imagine my delight when I came to know Mrs. Marcet personally; how often I cast my thoughts backward, delighting to connect the past and the present; how often, when sending

* Faraday loved this word and employed it to the last; he had an intense dislike to the modern term *physicist*.

† To whom I am indebted for a copy of the original letter.

a paper to her as a thank-offering, I thought of my first instructress, and such like thoughts will remain with me.

"I have some such thoughts even as regards *your own father;* who was, I may say, the first who personally at Geneva, and afterward by correspondence, encouraged, and by that sustained me."

Twelve or thirteen years ago Mr. Faraday and myself quitted the Institution one evening together, to pay a visit in Baker street. He took my arm at the door, and, pressing it to his side in his warm genial way, said, "Come, Tyndall, I will now show you something that will interest you." We walked northward, passed the house of Mr. Babbage, which drew forth a reference to the famous evening parties once assembled there. We reached Blandford street and after a little looking about, he paused before a stationer's shop, and then went in. On entering the shop, his usual animation seemed doubled; he looked rapidly at everything it contained. To the left on entering was a door, through which he looked down into a little room, with a window in front facing Blandford street. Drawing me toward him, he said eagerly, "Look there, Tyndall; that was my working-place. I bound books in that little nook." A respectable-looking woman stood behind the counter: his conversation with me was too low to be heard by her, and he now turned to the counter to buy some cards as an excuse for our being there. He asked the woman her name—her predecessor's name—his predecessor's name. "That won't do," he said, with good-humored impatience, who was *his* predecessor?" "Mr. Riebau," she replied, and immediately added, as if suddenly recollecting herself, "He, sir, was the master of Sir Charles Faraday." "Nonsense!" he responded, "there is no such person." Great was her delight when I told her the name of her visitor; but she assured me that as soon as she saw him running about the shop, she felt—though she did not know why—that it must "Sir Charles Faraday."

Faraday did, as you know, accompany Davy to Rome; he was re-engaged by the managers of the Royal Institution on the 15th of May, 1815. Here he made rapid progress in chemistry, and after a time was entrusted with easy analyses by Davy. In those days the Royal Institution published 'The Quarterly Journal of Science,' the precursor of our own 'Proceedings.' Faraday's first contribution to science appeared in that journal in 1816. It was an analyses of some caustic lime from Tuscany, which had been sent to Davy by the Duchess of Montrose. Between this period and 1818 various notes and papers were published by Faraday. In 1818 he experimented upon "Sounding Flames." Professor Auguste De la Rive, father of our present excellent De la Rive, had investigated

those sounding flames and had applied to them an explanation which completely accounted for a class of sounds discovered by De la Rive himself. By a few simple and conclusive experiments Faraday proved that the explanation was insufficient. It is an epoch in the life of a young man when he finds himself correcting a person of eminence, and in Faraday's case, where its effect was to develop a modest self-trust, such an event could not fail to act profitably.

From time to time between 1818 and 1820 Faraday published scientific notes and notices of minor weight. At this time he was acquiring, not producing; working hard for his master and storing and strengthening his own mind. He assisted Mr. Brande in his lectures, and so quietly, skilfully, and modestly was his work done, that Mr. Brande's vocation at the time was pronounced "lecturing on velvet." In 1820 Faraday published a chemical paper "on two new compounds of chlorine and carbon, and on a new compound of iodine, carbon, and hydrogen." This paper was read before the Royal Society on the 21st of Dec. 1820, and it was the first of his that was honored with a place in the 'Philosophical Transactions.'

On the 12th of June, 1821, he married, and obtained leave to bring his young wife into his rooms at the Royal Institution. There for forty-six years they lived together, occupying the suite of apartments which had been previously in the successive occupancy of Young, Davy, and Brande. At the time of her marriage Mrs. Faraday was twenty-one years of age, he being nearly thirty. Regarding this marriage I will at present limit myself to quoting an entry written in Faraday's own hand in his book of diplomas, which caught my eye while in his company some years ago. It ran thus:—

"25*th January*, 1847.

"Amongst these records and events, I here insert the date of one which, as a source of honor and happiness, far exceeds all the rest. We were *married* on the 12th of June, 1821.

"M. FARADAY."

Then follows the copy of the minutes, dated 21st May, 1821, which gave him additional rooms, and thus enabled him to bring his wife to the Royal Institution. A feature of Faraday's character which I have often noticed makes itself apparent in this entry. In his relations to his wife he added *chivalry* to affection.

Early Researches: Magnetic Rotations; Liquefaction of Gases: Heavy Glass: Charles Anderson: Contributions to Physics.

Oersted, in 1820, discovered the action of a voltaic current on a magnetic needle; and immediately afterward the splen-

did intellect of Ampère succeeded in showing that every magnetic phenomenon then known might be reduced to the mutual action of electric currents. The subject occupied all men's thoughts; and in this country Dr. Wollaston sought to convert the deflection of the needle by the current into a permanent *rotation* of the needle round the current. He also hoped to produce the reciprocal effect of causing a current to rotate round a magnet. In the early part of 1821 Wollaston attempted to realize this idea in the presence of Sir Humphry Davy in the laboratory of the Royal Institution. This was well calculated to attract Faraday's attention to the subject. He read much about it; and in the months of July, August, and September he wrote "a history of the progress of electromagnetism," which he published in Thomson's 'Annals of Philosophy.' Soon afterward he took up the subject of "Magnetic Rotations," and on the morning of Christmas day, 1821, he called his wife to witness for the first time the revolution of a magnetic needle round an electric current. Incidental to the "historic sketch" he repeated almost all the experiments there referred to; and these, added to his own subsequent work, made him practical master of all that was then known regarding the voltaic current. In 1821 he also touched upon a subject which subsequently received his closer attention—the vaporization of mercury at common temperatures; and immediately afterward conducted, in company with Mr. Stodart, experiments on the alloys of steel. He was accustomed in after years to present to his friends razors formed from one of the alloys then discovered.

During Faraday's hours of liberty from other duties he took up subjects of inquiry for himself; and in the spring of 1823, thus self-prompted, he began the examination of a substance which had long been regarded as the chemical element chlorine, in a solid form, but which Sir Humphry Davy, in 1810, had proved to be a hydrate of chlorine, that is, a compound of chlorine and water. Faraday first analyzed this hydrate, and wrote out an account of its composition. This account was looked over by Davy, who suggested the heating of the hydrate under pressure in a sealed glass tube. This was done. The hydrate fused at a blood-heat, the tube became filled with a yellow atmosphere and was found to contain two liquid substances. Dr. Paris happened to enter the laboratory while Faraday was at work. Seeing the oily liquid in his tube he rallied the young chemist for his carelessness in employing soiled vessels. On filing off the end of the tube its contents exploded and the oily matter vanished. Early next morning Dr. Paris received the following note :—

"*Dear Sir*—The *oil* you noticed yesterday turns out to be liquid chlorine. "Yours faithfully,

"M. FARADAY."*

The gas had been liquefied by its own pressure. Faraday then tried compression with a syringe, and succeeded thus in liquefying the gas.

To the published account of this experiment Davy added the following note :—"In desiring Mr. Faraday to expose the hydrate of chlorine in a closed glass tube, it occurred to me that one of three things would happen : that it would become fluid as a hydrate : that decomposition of water would occur ; . . . or that the chlorine would separate in a fluid state." Davy, moreover, immediately applied the method of self-compressing atmospheres to the liquefaction of muriatic gas. Faraday continued the experiments and succeeded in reducing a number of gases till then deemed permanent to the liquid condition. In 1844 he returned to the subject, and considerably expanded its limits. These important investigations established the fact that gases are but the vapors of liquids possessing a very low boiling-point, and gave a sure basis to our views of molecular aggregation. The account of the first investigation was read before the Royal Society on the 10th of April, 1823, and was published, in Faraday's name, in the 'Philosophical Transactions.' The second memoir was sent to the Royal Society on the 19th of December, 1844. I may add that while he was conducting his first experiments on the liquefaction of gases, thirteen pieces of glass were on one occasion driven by an explosion into Faraday's eye.

Some small notices and papers, including the observation that glass readily changes color in sunlight, follow here. In 1825 and 1826 Faraday published papers in the 'Philosophical Transactions' on "new compounds of carbon and hydrogen," and on "sulphonaphthalic acid." In the former of these papers he announced the discovery of benzol, which, in the hands of modern chemists, has become the foundation of our splendid aniline dyes. But he swerved incessantly from chemistry into physics ; and in 1826 we find him engaged in investigating the limits of vaporization, and showing, by exceedingly strong and apparently conclusive arguments, that even in the case of mercury such a limit exists ; much more he conceived it to be certain that our atmosphere does not contain the vapor of the fixed constituents of the earth's crust. This question, I may say, is likely to remain an open one. Mr. Rankine, for example, has lately drawn attention to the odor of certain metals ; whence comes this odor, if it be not from the vapor of the metal ?

* Paris: 'Life of Davy,' p. 391.

In 1825 Faraday became a member of a committee, to which Sir John Herschel and Mr. Dollond also belonged, appointed by the Royal Society to examine, and if possible improve, the manufacture of glass for optical purposes. Their experiments continued till 1829, when the account of them constituted the subject of a "Bakerian Lecture." This lectureship, founded in 1774 by Henry Baker, Esq., of the Strand, London, provides that every year a lecture shall be given before the Royal Society, the sum of four pounds being paid to the lecturer. The Bakerian Lecture, however, has long since passed from the region of pay to that of honor, papers of mark only being chosen for it by the council of the Society. Faraday's first Bakerian Lecture, "On the Manufacture of Glass for Optical Purposes," was delivered at the close of 1829. It is a most elaborate and conscientious description of processes, precautions, and results: the details were so exact and so minute, and the paper consequently so long, that three successive sittings of the Royal Society were taken up by the delivery of the lecture.* This glass did not turn out to be of important practical use, but it happened afterward to be the foundation of two of Faraday's greatest discoveries.†

The experiments here referred to, were commenced at the Falcon Glass Works, on the premises of Messrs. Green and Pellatt, but Faraday could not conveniently attend to them there. In 1827 therefore a furnace was erected in the yard of the Royal Institution; and it was at this time, and with a view of assisting him at the furnace, that Faraday engaged Sergeant Anderson, of the Royal Artillery, the respectable, truthful, and altogether trustworthy man whose appearance here is so fresh in our memories. Anderson continued to be the reverential helper of Faraday and the faithful servant of this Institution for nearly forty years.‡

* *Viz.* November 19, December 3 and 10.

† I make the following extract from a letter from Sir John Herschel, written to me from Collingwood, on the 3rd of November, 1867:—

"I will take this opportunity to mention that I believe myself to have originated the suggestion of the employment of borate of lead for *optical* purposes. It was somewhere in the year 1822, as well as I can recollect, that I mentioned it to Sir James (then Mr.) South; and, in consequence, the trial was made in his laboratory in Blackman street, by precipitating and working a large quantity of borate of lead, and fusing it under a muffle in a porcelain evaporating dish. A very limpid (though slightly yellow) glass resulted, the refractive index 1·866! (which you will find set down in my table of refractive indices in my article 'Light,' 'Encyclopædia Metropolitana'). It was, however, too soft for optical use as an object glass. This Faraday overcame at least to a considerable degree, by the introduction of silica."

‡ Regarding Anderson, Faraday writes thus in 1845:—"I cannot resist the occasion that is thus offered to me of mentioning the name of Mr. Anderson, who came to me as an assistant in the glass experiments, and has remained ever since in the laboratory of the Royal Institution. He assisted me in all the researches into which I have entered since that time; and to his care, steadiness, exactitude, and faithfulness in the performance of all that has been committed to his charge, I am much indebted.—M. F."—*Exp. Researches*, vol. iii, p. 3, footnote.

In 1831 Faraday published a paper "On a peculiar class of Optical Deceptions," to which I believe the beautiful optical toy called the Chromatrope owes its origin. In the same year he published a paper on Vibrating Surfaces, in which he solved an acoustical problem which, though of extreme simplicity *when solved*, appears to have baffled many eminent men. The problem was to account for the fact that light bodies, such as the seed of lycopodium, collected at the vibrating parts of sounding plates, while sand ran to the nodal lines. Faraday showed that the light bodies were entangled in the little whirlwinds formed in the air over the places of vibration, and through which the heavier sand was readily projected. Faraday's resources as an experimentalist were so wonderful, and his delight in experiment was so great, that he sometimes almost ran into excess in this direction. I have heard him say that this paper on vibrating surfaces was too heavily laden with experiments.

Discovery of Magneto-electricity: Explanation of Arago's Magnetism of Rotation: Terrestrial Magneto-electric Induction: The Extra Current.

The work thus far referred to, though sufficient of itself to secure no mean scientific reputation, forms but the vestibule of Faraday's achievements. He had been engaged within these walls for eighteen years.* During part of the time he had drunk in knowledge from Davy, and during the remainder he continually exercised his capacity for independent inquiry. In 1831 we have him at the climax of his intellectual strength, forty years of age, stored with knowledge and full of original power. Through reading, lecturing, and experimenting, he had become thoroughly familiar with electrical science: he saw where light was needed and expansion possible. The phenomena of ordinary electric induction belonged, as it were, to the alphabet of his knowledge; he knew that under ordinary circumstances the presence of an electrified body was sufficient to excite, by induction, an unelectrified body. He knew that the wire which carried an electric current was an electrified body, and still that all attempts had failed to make it excite in other wires a state similar to its own.

What was the reason of this failure? Faraday never could work from the experiments of others, however clearly described. He knew well that from every experiment issued a kind of radiation, luminous in different degrees to different minds, and he hardly trusted himself to reason upon an experiment that he had not seen. In the autumn of 1831 he began to repeat

* He used to say that it required twenty years of work to make a *man* in Physical Science; the previous period being one of *infancy*.

the experiments with electric currents, which, up to that time, had produced no positive result. And here, for the sake of younger inquirers, if not for the sake of us all, it is worth while to dwell for a moment on a power which Faraday possessed in an extraordinary degree. He united vast strength with perfect flexibility. His momentum was that of a river which combines weight and directness with the ability to yield to the flexures of its bed. The intentness of his vision in any direction did not apparently diminish his power of perception in other directions; and when he attacked a subject, expecting results, he had the faculty of keeping his mind alert, so that results different from those which he expected should not escape him through preoccupation.

He began his experiments "on the induction of electric currents" by composing a helix of two insulated wires, which were wound side by side round the same wooden cylinder. One of these wires he connected with a voltaic battery of ten cells, and the other with a sensitive galvanometer. When connection with the battery was made, and while the current flowed, no effect whatever was observed at the galvanometer. But he never accepted an experimental result, until he had applied to it the utmost power at his command. He raised his battery from 10 cells to 120 cells, but without avail. The current flowed calmly through the battery wire without producing, during its flow, any sensible result upon the galvanometer.

"During its flow," and this was the time when an effect was expected—but here Faraday's power of lateral vision, separating, as it were, from the line of expectation, came into play—he noticed that a feeble movement of the needle always occurred at the moment when he made contact with the battery; that the needle would afterward return to its former position and remain quietly there, unaffected by the *flowing* current. At the moment, however, when the circuit was interupted the needle again moved, and in a direction opposed to that observed on the completion of the circuit.

This result and others of a similar kind led him to the conclusion "that the battery current through the one wire did in reality induce a similar current through the other; but that it continued for an instant only, and partook more of the nature of the electric wave from a common Leyden jar than of the current from a voltaic battery." The momentary currents thus generated were called *induced currents*, while the current which generated them was called the *inducing* current. It was immediately proved that the current generated at making the circuit was always opposed in direction to its generator, while that developed on the rupture of the circuit coincided in direc-

tion with the inducing current. It appeared as if the current on its first rush through the primary wire sought a purchase in the secondary one, and, by a kind of kick, impelled backward through the latter an electric wave, which subsided as soon as the primary current was fully established.

Faraday for a time believed that the secondary wire, though quiescent when the primary current had been once established, was not in its natural condition, its return to that condition being declared by the current observed at breaking the circuit. He called this hypothetical state of the wire the *electro-tonic state:* he afterward abandoned this hypothesis, but seemed to return to it in later life. The term electro-tonic is also preserved by Professor Du Bois Reymond to express a certain electric condition of the nerves, and Professor Clerk Maxwell has ably defined and illustrated the hypothesis in the tenth volume of the 'Transactions of the Cambridge Philosophical Society.'

The mere approach of a wire forming a closed curve to a second wire through which a voltaic current flowed was then shown by Faraday to be sufficient to arouse in the neutral wire an induced current, opposed in direction to the inducing current; the withdrawal of the wire also generated a current having the same direction as the inducing current; those currents existed only during the time of approach or withdrawal, and when neither the primary nor the secondary wire was in motion, no matter how close their proximity might be, no induced current was generated.

Faraday has been called a purely inductive philosopher. A great deal of nonsense is, I fear, uttered in this land of England about induction and deduction. Some profess to befriend the one, some the other, while the real vocation of an investigator, like Faraday, consists in the incessant marriage of both. He was at this time full of the theory of Ampère, and it cannot be doubted that numbers of his experiments were executed merely to test his deductions from that theory. Starting from the discovery of Oersted, the celebrated French philosopher had shown that all the phenomena of magnetism then known might be reduced to the mutual attractions and repulsions of electric currents. Magnetism had been produced from electricity, and Faraday, who all his life long entertained a strong belief in such reciprocal actions, now attempted to effect the evolution of electricity from magnetism. Round a welded iron ring he placed two distinct coils of covered wire, causing the coils to occupy opposite halves of the ring. Connecting the ends of one of the coils with a galvanometer, he found that the moment the ring was magnetized by sending a current through *the other coil,* the galvanometer needle whirled round four or

five times in succession, the action, as before, was that of a pulse which vanished immediately. On interrupting the circuit, a whirl of the needle in the opposite direction occurred. It was only during the time of magnetization or demagnetization that these effects were produced. The induced currents declared a *change* of condition only, and they vanished the moment the act of magnetization or demagnetization was complete.

The effects obtained with the welded ring were also obtained with straight bars of iron. Whether the bars were magnetized by the electric current, or were excited by the contact of permanent steel magnets, induced currents were always generated during the rise and during the subsidence of the magnetism. The use of iron was then abandoned, and the same effects obtained by merely thrusting a permanent steel magnet into a coil of wire. A rush of electricity through the coil accompanied the insertion of the magnet; an equal rush in the opposite direction accompanied its withdrawal. The precision with which Faraday describes these results, and the completeness with which he defines the boundaries of his facts, are wonderful. The magnet, for example, must not be passed quite through the coil, but only half through, for if passed wholly through, the needle is stopped as by a blow, and then he shows how this blow results from a reversal of the electric wave in the helix. He next operated with the powerful permanent magnet of the Royal Society, and obtained, with it, in an exalted degree, all the foregoing phenomena.

And now he turned the light of these discoveries upon the darkest physical phenomena of that day. Arago had discovered in 1824, that a disk of non-magnetic metal had the power of bringing a vibrating magnetic needle suspended over it rapidly to rest; and that on causing the disk to rotate the magnetic needle rotated along with it. When both were quiescent, there was not the slightest measurable attraction or repulsion exerted between the needle and the disk; still when in motion the disk was competent to drag after it not only a light needle but a heavy magnet. The question had been probed and investigated with admirable skill by both Arago and Ampère, and Poisson had published a theoretic memoir on the subject; but no cause could be assigned for so extraordinary an action. It had also been examined in this country by two celebrated men, Mr. Babbage and Sir John Herschel; but it still remained a mystery. Faraday always recommended the suspension of judgment in cases of doubt. "I have always admired," he says, "the prudence and philosophical reserve shown by M. Arago in resisting the temptation to give a theory of the effect he had discovered, so long as he could not devise one which was perfect in its ap-

plication, and in refusing to assent to the imperfect theories of others." Now, however, the time for theory had come. Faraday saw mentally the rotating disk under the operation of the magnet flooded with his induced currents; and from the known laws of interaction between currents and magnets he hoped to deduce the motion observed by Arago. That hope he realized, showing by actual experiment that when his disk rotated currents passed through it, their position and direction being such as must, in accordance with the established laws of electro-magnetic action, produce the observed rotation.

Introducing the edge of his disk between the poles of the large horseshoe magnet of the Royal Society, and connecting the axis and the edge of the disk, each by a wire with a galvanometer, he obtained when the disk was turned round a constant flow of electricity. The direction of the current was determined by the direction of the motion, the current being reversed when the rotation was reversed. He now states the law which rules the production of currents in both disks and wires, and in so doing uses for the first time a phrase which has since become famous. When iron filings are scattered over a magnet, the particles of iron arrange themselves in certain determinate lines called magnetic curves. In 1831, Faraday for the first time called these curves "lines of magnetic force;" and he showed that to produce induced currents neither approach to nor withdrawal from a magnetic source, or center, or pole, was essential, but that it was only necessary to cut appropriately the lines of magnetic force. Faraday's first paper on magneto-electric induction, which I have here endeavored to condense, was read before the Royal Society on the 24th of November, 1831.

On the 12th of January, 1832, he communicated to the Royal Society a second paper on Terrestrial Magneto-electric Induction, which was chosen as the Bakerian Lecture for the year. He placed a bar of iron in a coil of wire, and lifting the bar into the direction of the dipping needle, he excited by this action a current in the coil. On reversing the bar, a current in the opposite direction rushed through the wire. The same effect was produced, when, on holding the helix in the line of dip, a bar of iron was thrust into it. Here, however, the earth acted on the coil through the intermediation of the bar of iron. He abandoned the bar and simply set a copper-plate spinning in a horizontal plane; he knew that the earth's lines of magnetic force then crossed the plate at an angle of about 70°. When the plate spun round, the lines of force were intersected and induced currents generated, which produced their proper effect when carried from the plate to the galvanometer. "When the plate was in the magnetic meridian, or in any other plane

coinciding with the magnetic dip, then its rotation produced no effect upon the galvanometer."

At the suggestion of a mind fruitful in suggestions of a profound and philosophic character—I mean that of Sir John Herschel—Mr. Barlow, of Woolwich, had experimented with a rotating iron shell. Mr. Christie had also performed an elaborate series of experiments on a rotating iron disk. Both of them had found that when in rotation the body exercised a peculiar action upon the magnetic needle, deflecting it in a manner which was not observed during quiescence; but neither of them was aware at the time of the agent which produced this extraordinary deflection. They ascribed it to some change in the magnetism of the iron shell and disk.

But Faraday at once saw that his induced currents must come into play here, and he immediately obtained them from an iron disk. With a hollow brass ball, moreover, he produced the effects obtained by Mr. Barlow. Iron was in no way necessary: the only condition of success was that the rotating body should be of a character to admit of the formation of currents in its substance: it must, in other words, be a conductor of electricity. The higher the conducting power, the more copious were the currents. He now passes from his little brass globe to the globe of the earth. He plays like a magician with the earth's magnetism. He sees the invisible lines along which its magnetic action is exerted, and sweeping his wand across these lines he evokes this new power. Placing a simple loop of wire round a magnetic needle he bends its upper portion to the west: the north pole of the needle immediately swerves to the east: he bends his loop to the east, and the north pole moves to the west. Suspending a common bar magnet in a vertical position he causes it to spin round its own axis. Its pole being connected with one end of a galvanometer wire, and its equator with the other end, electricity rushes round the galvanometer from the rotating magnet. He remarks upon the "*singular independence*" of the magnetism and the body of the magnet which carries it. The steel behaves as if it were isolated from its own magnetism.

And then his thoughts suddenly widen, and he asks himself whether the rotating earth does not generate induced currents as it turns round its axis from west to east. In his experiment with the twirling magnet the galvanometer wire remained at rest; one portion of the circuit was in motion *relatively* to *another portion*. But in the case of the twirling planet the galvanometer wire would necessarily be carried along with the earth; there would be no relative motion. What must be the consequence? Take the case of a telegraph wire with its two

terminal plates dipped into the earth, and suppose the wire to lie in the magnetic meridian. The ground underneath the wire is influenced like the wire itself by the earth's rotation; if a current from south to north be generated in the earth under the wire, a similar current from south to north would be generated in the earth under the wire; these currents would run against the same terminal plate, and thus neutralize each other.

This inference appears inevitable, but his profound vision perceived its possible invalidity. He saw that it was at least possible that the difference of conducting power between the earth and the wire might give one an advantage over the other, and that thus a residual or differential current might be obtained. He combined wires of different materials, and caused them to act in opposition to each other: but found the combination ineffectual. The more copious flow in the better conductor was exactly counterbalanced by the resistance of the worst. Still though experiment was thus emphatic he would clear his mind of all discomfort by operating on the earth itself. He went to the round lake near Kensington Palace, and stretched 480 feet of copper wire, north and south, over the lake, causing plates soldered to the wire at its ends to dip into the water. The copper wire was severed at the middle, and the severed ends connected with a galvanometer. No effect whatever was observed. But though quiescent water gave no effect, moving water might. He therefore worked at London Bridge for three days during the ebb and flow of the tide, but without any satisfactory result. Still he urges, "Theoretically it seems a necessary consequence, that where water is flowing there electric currents should be formed. If a line be imagined passing from Dover to Calais through the sea, and returning through the land, beneath the water, to Dover, it traces out a circuit of conducting matter one part of which, when the water moves up or down the channel, is cutting the magnetic curves of the earth, whilst the other is relatively at rest. . . . There is every reason to believe that currents do run in the general direction of the circuit described, either one way or the other, according as the passage of the waters is up or down the Channel." This was written before the submarine cable was thought of, and he once informed me that actual observation upon that cable had been found to be in accordance with his theoretic deduction.*

* I am indebted to a friend for the following exquisite morsel:—"A short time after the publication of Faraday's first researches in magneto-electricity, he attended the meeting of the British Association at Oxford, in 1832.—On this occasion he was requested by some of the authorities to repeat the celebrated experiment of eliciting a spark from a magnet, employing for this purpose the large magnet in the Ashmolean Museum. To this he consented, and a large party assembled to witness the

Three years subsequent to the publication of these researches, that is to say on the 29th of January, 1835, Faraday read before the Royal Society a paper "On the influence by induction of an electric current upon itself." A shock and spark of a peculiar character had been observed by a young man named William Jenkin, who must have been a youth of some scientific promise, but who, as Faraday once informed me, was dissuaded by his own father from having anything to do with science. The investigation of the fact noticed by Mr. Jenkin led Faraday to the discovery of the *extra current*, or the current *induced in the primary wire itself* at the moments of making and breaking contact, the phenomena of which he described and illustrated in the beautiful and exhaustive paper referred to.

Seven and thirty years have passed since the discovery of magneto-electricity; but, if we except the *extra current*, until quite recently nothing of moment was added to the subject. Faraday entertained the opinion that the discoverer of a great law or principle had a right to the "spoils"—this was his term—arising from its illustration; and guided by the principle he had discovered, his wonderful mind, aided by his wonderful ten fingers, overran in a single autumn this vast domain, and hardly left behind him the shred of a fact to be gathered by his successors.

And here the question may arise in some minds, What is the use of it all? The answer is, that if man's intellectual nature thirsts for knowledge, then knowledge is useful because it satisfies this thirst. If you demand practical ends, you must, I think, expand your definition of the term practical, and make it include all that elevates and enlightens the intellect, as well as all that ministers to the bodily health and comfort of men. Still, if needed, an answer of another kind might be given to the question, "What is its use?" As far as electricity has been applied for medical purposes it has been almost exclusively Faraday's electricity. You have noticed those lines of wire which cross the streets of London. It is Faraday's currents

experiments, which, I need not say, were perfectly successful. Whilst he was repeating them a dignitary of the university entered the room, and addressing himself to Professor Daniell, who was standing near Faraday, inquired what was going on. The Professor explained to him as popularly as possible this striking result of Faraday's great discovery. The Dean listened with attention and looked earnestly at the brilliant spark, but a moment after he assumed a serious countenance and shook his head; 'I am sorry for it,' said he as he walked away; in the middle of the room he stopped for a moment and repeated, 'I am sorry for it;' then walking toward the door, when the handle was in his hand he turned round and said, '*Indeed* I am sorry for it; it is putting new arms into the hands of the incendiary.' This occurred a short time after the papers had been filled with the doings of the hayrick burners. An erroneous statement of what fell from the Dean's mouth was printed at the time in one of the Oxford papers. He is there wrongly stated to have said, 'It is putting new arms into the hands of the infidel.'"

that speed from place to place through these wires. Approaching the point of Dungeness the mariner sees an unusually brilliant light, and from the noble *phares* of La Hève the same light flashes across the sea. These are Faraday's sparks exalted by suitable machinery to sunlike splendor. At the present moment the Board of Trade and the Bretheren of the Trinity House, as well as the Commissioners of Northern Lights, are contemplating the introduction of the magneto-electric light at numerous points upon our coasts; and future generations will be able to refer to those guiding stars in answer to the question, What has been the practical use of the labors of Faraday? But I would again emphatically say that his work needs no such justification, and that if he had allowed his vision to be disturbed by considerations regarding the practical use of his discoveries, those discoveries would never have been made by him. "I have rather," he writes in 1831, "been desirous of discovering new facts and new relations dependent on magneto-electric induction, than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter."

In 1817, when lecturing before a private society in London on the element chlorine, Faraday thus expresses himself with reference to this question of utility:—"Before leaving this subject, I will point out the history of this substance, as an answer to those who are in the habit of saying to every new fact, 'What is its use?' Dr. Franklin says to such, 'What is the use of an infant?' The answer of the experimentalist is, 'Endeavor to make it useful.' When Scheele discovered this substance it appeared to have no use; it was in its infancy and useless state, but having grown up to maturity, witness its powers, and see what endeavors to make it useful have done."

Art. VII.—*Chemical Apparatus;* by W. P. Dexter.

Gas lamps for the ignition of crucibles, &c.—The ordinary Bunsen burner is known to act upon the surface of platinum vessels brought in contact with the inner line of the flame: the metal loses its polish, becoming superficially porous and spongy, and requires the use of the burnisher to bring it back to its original state. This alteration of the surface I have found to be attended with a change of weight, so that for some years I have used a lamp of different construction for the heating of platinum crucibles in analytical operations. Such a lamp may be made by removing the air tube of a common Bunsen lamp and putting in its place a somewhat

longer one of glass or iron of about 12 millimeters internal diameter. The gas jet should have a single circular aperture, and be in proper proportion to the diameter of the tube, which may be held in any of the ordinary clamp supports. The tube being raised sufficiently above the jet to allow free entrance of air, and a full stream of gas let on, a "roaring" flame is produced, of which the interior blue cone is pointed, sharply defined, and extends only about half an inch from the top of the tube. A polished platinum surface is not acted upon by this flame provided it be not brought into contact with the interior cone. In the Bunsen burner, as usually made, the supply of air depends upon the diameter of the tube, the holes at its base being more than sufficient to supply the draught. With the wider tube it is necessary to limit the admission of air by depressing the tube upon the lamp when the force of the gas is diminished. Otherwise the proportion becomes such that an explosive mixture is formed; for this reason it is more convenient to use an arrangement in which the access of air can be regulated by an exterior tube sliding obliquely downward over the air apertures. The gas jet should be on a level with the top of these apertures, which must be much larger than those of the ordinary Bunsen's burner.

On account of the liability to explode and burn at the jet inside, the lamp is not well adapted for ordinary use; but for ignition of crucibles, working of glass, &c., it has proved efficient and practical.

Gas regulator.—Now that gas is universally used as a source of heat in laboratories, it is desirable to have a means of keeping the pressure constant, and independent of the changes which take place in the mains. By the Regulator of Kemp a uniform temperature can be kept up for any length of time; but this apparatus is a little difficult to adjust, is not universally applicable, and can be used in but one operation at a time. By regulating the pressure of the gas, on the other hand, a constant supply of heat is furnished, but the temperature is not so exactly maintained in consequence of the more or less rapid abstraction of heat by change of temperature of the locality, and from currents of air. It is, however, as constant as it can be kept by a spirit lamp, which we are at present often obliged, from the variations of pressure, to substitute for gas; while the regulator may be connected with several burners, or even include the whole laboratory, if the gas pipes are of sufficient size.

The arrangement which I have had in use for the last year consists of a common gasometer, made of zinc, and about 9 inches in height and diameter. The floating bell is connected

by a jointed rod with a stopcock in the pipe by which the gas enters. When the bell rises from the pressure of the gas, it gradually closes this cock, and thus cuts off the further supply. The gas is then under a constant pressure depending upon the weight of the bell; as gas is consumed the bell sinks and opening the cock allows more to flow in. The difference of weight of the bell from its greater or less immersion in the water is inappreciable; a very slight diminution of pressure, hardly perceptible without a microscope, is observed when one of the outlets is suddenly thrown open to its full extent, and is due, probably, to the friction of the gas in the tubes, which should therefore be of considerable size.

The apparatus should not be painted, as oil is acted upon by water which has been long in contact with gas. Asphaltum varnish seems to answer better.

ART. VIII.—*On the Equivalent of Cerium;* by the late Dr. CHARLES WOLF, of Cincinnati, Ohio.

AT the suggestion of Professor Bunsen in Heidelberg, the father of the late Dr. Charles Wolf of Cincinnati, Ohio, placed in my hands, papers and preparations relating to an investigation, which his son had made, while in the laboratory of Prof. Bunsen, and requested me to collate the same and prepare them for publication. This task I cheerfully accepted, the more, that I deemed the death of this young and promising chemist a real loss to the cause of science.

I here give a translation of Dr. Wolf's investigation on the equivalent of cerium, which Bunsen pronounces very valuable. I have examined all the data with the greatest care and gone over a great many of his analyses and calculations. The paper was about complete, when it came into my hands, all but a few of the last pages, which were in the shape of notes, but these were sufficiently copious to enable me to finish it, with the aid of some analyses, which I found among his papers.

I could not find the description of the crystalline form of his salts, to which he refers, nor is there the least evidence that any measurements have ever been made. This investigation may be of value to chemists laboring in the same field, as it designates the probable existence of *another* foreign substance in the "cerite-oxyds," and we must deeply regret that its author was not spared long enough to conclude his researches on the nature of this oxyd, which so considerably increases the equivalent of cerium.

Let us hope that the hints and suggestions thrown out by

Dr. Wolf may not be lost, but that they may induce some investigator to advance or conclude this highly interesting subject.

F. A. GENTH.

Philadelphia, April 26th, 1868.

Since the discovery of the peculiar oxyds contained in the cerite by Berzelius & Hisinger* and Mosander† they have been the subject of numerous researches. Their occurrence together with their very similar chemical properties presented very great difficulties in their separation and indeed the mixture of the three oxyds was for a long time looked upon as the oxyd of *one metal only*, which was called *cerium*. Notwithstanding the many investigations made on this subject, the methods for the separation and purification of the three cerite-oxyds are very imperfect.

The oxyd of cerium, which in its properties differs most from the oxyd of didymium and from lanthana, and which is the most common, is more readily obtained in a state of perfect purity than either of the two others.

The following investigation was made for the purpose of preparing salts of cerium of *absolute* purity, so as to determine from them the equivalent of the metal. The material used was Swedish cerite.

The method adopted for the preparation of the oxyds was substantially that recommended by Bunsen,‡ with some slight alterations, as will be seen from the following description.

The finely pulverized mineral, mixed in a porcelain dish with oil of vitriol to the consistency of a stiff paste, was put into a hessian crucible and exposed to a dull red heat. The excess of sulphuric acid was driven off and the ash-grey mass finely pulverized and gradually added to a large dish full of ice-water and ice. It was then agitated until the water had become saturated, when it was allowed to settle. The saturated solution was afterward poured off and the residue washed until the liquid became tasteless and gave no further precipitate with oxalic acid.

After having been concentrated by evaporation this solution was precipitated by sulphydric acid and filtered. The excess of sulphydric acid was driven off by heat, the liquid was then oxydized by chlorine, after which the excess of the latter was also expelled by heat. It was then strongly acidulated by chlorhydric acid, heated up to boiling and precipitated by a boiling solution of oxalic acid, while being constantly stirred. The precipitate of crystalline oxalates, which settled easily, was

* Berzelius & Hisinger, Gehlen's Journ. der Chemie, ii, 397.

† Mosander, Journ. fur pract. Chemie, xxx, 1843; Pogg. Ann., clvi, 1843; Edin. & Dubl. Phil. Mag., Oct. 1843.

‡ Bunsen, Annalen der Chem. & Pharm., cv, 1858.

decanted and washed with boiling water. The mother-liquor still contained a large portion of the rare oxyds, but these were very much mixed with other bases.

The dried oxalates were then placed into a porcelain dish and decomposed by heat over an open fire, care being taken to stir them constantly. Should this precaution be neglected they might cake together, in which case a portion of the salt would remain undecomposed. Concentrated nitric acid was now poured upon the cinnamon-brown powder and the mixture was heated until the oxyds were dissolved.

The deep red violet solution was freed as much as possible from the excess of nitric acid by evaporation, and while still warm it was poured in a boiling mixture of water and sulphuric acid, containing 2 c. c. of sulphuric acid per liter of water.

The red violet color at once disappeared, and while a great evolution of gas took place, a dirty yellow precipitate of basic ceroso-ceric sulphate was formed. The mixture was allowed to boil up two or three times; it was then removed from the fire, when the precipitate settled rapidly.

Should the quantity of sulphuric acid and water have been insufficient, a portion of the nitric acid solution remains undecomposed and the supernatant liquid is yellow; this is also the case when the sulphuric acid water is too concentrated, because then a portion of the precipitate is dissolved by the excess of the acid. If the right proportions have been used, the supernatant liquid will have an amethystine color from the presence of didymium; in it neither boiling nor the addition of water or a few drops of sulphuric acid will give a precipitate. A few preliminary experiments will determine the requisite quantities of water and sulphuric acid.

The basic precipitate was washed by decantation, at first with boiling water containing per liter 1 c. c. of sulphuric acid, then with boiling distilled water. The precipitate settles easily. It is well to preserve the first wash-waters, since a portion of the precipitate dissolves in them even to the extent of one third. The last portion of the filtrate resulting from the washings with pure water need not be saved, as they contain traces only of the precipitate.

This basic sulphate, although sometimes prepared by a different process, has been used by most chemists as a starting point for the preparation of pure salts of cerium, and the sulphate obtained from it has served for the determination of its equivalent.

The washed basic salt, obtained by the method above mentioned, I divided into two equal parts; with the one I repeated the experiments made by previous observers, while the other

supplied me with the material for some new experiments, which I shall detail in due season. The first part was dissolved by the addition of a few drops of sulphuric acid and slightly heated, the yellowish-red solution reduced by sulphurous acid and evaporated to dryness. The dry salt, heated in a platinum crucible, was freed from its excess of sulphuric acid and water; the cerous sulphate therefrom resulting was dissolved in cold water, filtered and very slowly evaporated over a water bath. The slower the evaporation the better will the crystals be.

When but little of the mother-liquor remained, this was poured off, the salt washed twice with boiling water, and the purified salt dried over a water bath.

Upon being tested with the spectroscope, the mother-liquor showed the whole absorption spectrum of didymium, with the same distinctness as a moderately concentrated solution of didymium would do.

A solution of the purified crystals gave such lines as in the didymium spectrum are usually marked by their intensity. A small portion of the mother-liquor precipitated by oxalic acid gave on ignition of the oxalate an oxyd of a brown color, while the ceroso-ceric oxyd obtained by a similar process from the sulphate had already a brick-red color. For the purpose of further purification the whole mass of the sulphate was recrystallized five times in the manner above stated and the mother-liquor always separated from the crystals, then the salt was separated by fractional crystallization into five equal portions, as follows:

The mass of the crystals into		A_1 ; A_2 ; A_3
A_1	"	B_1 ; B_2
B_1	"	C_1 ; C_2

Of these salts B_2, C_1 and C_2 were analyzed.

The following method was in general adopted: About 1·5 grams of the salt, which had previously been dried over chlorid of calcium, was weighed in a tared platinum crucible; this was transferred into a larger platinum crucible, in the bottom of which was a thick platinum spire, upon which the smaller crucible rested, fully surrounded by air. The large crucible covered by a mica plate was then very carefully heated during three hours, high over a small gas flame, and weighed. These weighings were repeated, the crucible remaining at the same height over the flame, while the heat was gradually increased, until finally a point was reached, when, notwithstanding a considerable increase in the temperature, the weight of the crucible remained invariable. From five to eight weighings generally sufficed to give the amount of water.

The anhydrous salt was then dissolved in a large quantity of water, the solution heated and precipitated by a concentrated boiling solution of oxalic acid. The filtrate should always be tested by ammonia and should not give a precipitate, if the proportions of oxalic acid are correct.

The greatest precautions are necessary in the ignition of the oxalate, because the resulting ceroso-ceric oxyd is in such an exceedingly finely divided condition that the slightest shaking will occasion a loss, unless the crucible be covered by a well fitting lid.

The resulting ceroso-ceric oxyd was always analyzed and the amount of cerous oxyd corresponding with it determined according to Bunsen's volumetric method by iodid of potassium and chlorhydric acid from the amount of liberated iodine.

1.—1·4542 grs. of B_2 gave 0·19419 grs. water and 0·76305 grs. ceroso-ceric oxyd, corresponding with 0·72443 grs. cerous oxyd; 0·70325 grs. of ceroso-ceric oxyd gave 0·66766 grs. of cerous oxyd.

2.—1·4104 grs. of C_1 gave 0·1898 grs. water and 0·7377 grs. of ceroso-ceric oxyd, giving 0·70217 grs. of cerous oxyd.

3.—1·35027 grs. of C_2 gave 0·1820 grs. water and 0·70665 grs. of ceroso-ceric oxyd, corresponding with 0·67261 grs. cerous oxyd; 0·6916 grs. ceroso-ceric oxyd gave 0·65829 grs. cerous oxyd.

According to these results the anhydrous sulphate contains as follows:

	B_2	C_1	C_2	Mean.
Cerous oxyd,	57·494	57·526	57·574	57·531
Sulphuric acid,	42·506	42·474	42·426	42·469
	100·000	100·000	100·000	100·000

B_2	would give for the equivalent of cerium		46·104
C_1	"	"	46·176
C_2	"	"	46·281

giving as the mean result=46·187.

The anhydrous sulphate consists according to these numbers of one equivalent of base for one of acid.

The composition of the crystals is as follows:

	B_2	C_1	C_2	Mean.	Calculated.
Cerous oxyd,	49·816	49·785	49·813	49·805	49·628
Sulphuric acid,	36·830	36·758	36·708	36·765	36·634
Water,	13·354	13·457	13·479	13·430	13·738
	100·000	100·000	100·000	100·000	100·000

These results agree with the calculated analysis, which corresponds to the formula: $3(CeO, SO_3)+5HO$.

The equivalent 46·187 has been used for these calculations. The salt, which gave these results was crystallized in small crystals, elongated in one direction, the crystallographic description of which I shall subsequently give.

Let us compare this equivalent with the results which were previously obtained by other observers.

Beringer* made in Wöhler's laboratory four determinations of the equivalent of cerium. His salts were all prepared from the residue, remaining after the extraction of the mixed cerite-oxyds by dilute nitric acid. They were all rose-colored.

From the pale rose-colored cerous sulphate he obtained the number:	577·24	46·179
From the like colored cerous chlorid,	576·97	46·158
By the conversion of the sulphid into oxyd,	576·69	46·127
From the cerous formate,	576·00	46·080
Mean,	576·73	46·138

Hermann† found the number 575·00=46·00 by an analysis of the cerous sulphate prepared from the basic sulphate. In this case likewise the mixed oxyds were first extracted by nitric acid.

Marignac‡ used for his determinations the cerous sulphate, which was prepared from the basic sulphate, purified by several re-crystallizations. The basic sulphate was prepared from the mixed oxyds, remaining after having been extracted by nitric acid. The residue was dissolved in sulphuric acid, and the basic salt precipitated by dilution with water. Marignac adopts the number 46·00 as the equivalent of cerium.

Under the guidance of Bunsen,§ Jegel made several experiments. The mixed oxalates were ignited with *magnesia alba*, then dissolved in boiling nitric acid and the solution evaporated to crystallization. The solution of these crystals in water, when poured in boiling water, containing sulphuric acid, produced the basic ceric sulphate, from which the neutral cerous salt was obtained, which gave:

576·3	575·25	575·65	Mean { 575·73
46·104	46·020	46·050	{ 46·058

Rammelsberg‖ obtained by the analysis of the cerous oxalate the number 575·90=46·072.

* Beringer, Annalen der Chemie & Pharm., xlii, 1842.

† Hermann, Journ. für Pract. Chemie, xxx, 1843.

‡ Marignac, Ann. de Chimie et Phys., III, xxxviii, 148; Ann. der Chem. und Pharm., lxviii, 1848.

§ Bunsen, Annalen der Chem. & Pharm., cv, 1858.

‖ Rammelsberg, Poggendorf's Ann., cviii, 1859.

To facilitate comparison I will tabulate the different results:

	O=100	H=1
Beringer,	576·73	46·138
Hermann,	575·00	46·000
Marignac,	575·00	46·000
Bunsen,	575·73	46·058
Rammelsberg,	575·90	46·072
Wolf,	577·33	46·187

The new number differs from all the others and is even higher than that obtained by Beringer with far less purified material; all his salts were rose-colored, owing to the presence of didymium, my salts, on the contrary, were perfectly colorless, each had been re-crystallized at least ten times (always rejecting the mother-liquor).

Having used the very greatest care both in the preparation and in the analyses of the salt, it is difficult to account for this high result; either the same analytical error has been committed in the three analyses, or there may be present *another* foreign substance besides didymium. The first supposition is contradicted by analyses, which have been made by exactly the same methods and which will be given hereafter, while the second I shall discuss presently.

A sample of salt, which had been re-crystallized twenty times, still distinctly showed the line D of the absorption spectrum of didymium, and it being evident that by crystallization *alone* no absolutely pure cerous sulphate can be prepared, it was therefore necessary to search for another method for its preparation. To ascertain the purity of the resulting product the cerous oxalate was used, and from the color of the oxyd produced by its ignition the state of purity was readily ascertained.

Mosander had already correctly stated that the brown color of the mixed oxyds was due to the presence of foreign substances; he obtained the ceroso-ceric oxyd of a reddish white color; Hermann had it of an isabel color. By a slight alteration in the mode of preparation, Bunsen obtained it of a yellowish white color. On my part I have made numerous experiments in order to produce it as white as possible.

For this purpose the previously mentioned second portion of the basic sulphate was used. Out of the numerous methods which I have tried, but *two* have given encouraging results.

The first was as follows: A small portion of the precipitate was dissolved by heating it with a few drops of sulphuric acid and this solution precipitated by pouring it into a large quantity of boiling water. After its conversion into oxalate the new precipitate gave a paler ceroso-ceric oxyd; a repetition of

the same process still gave a better result, but the reduction in color was not very rapid and it would have required at least eight or ten precipitations to produce as pale an oxyd as that obtained by the following process; besides, another disadvantage, incident to these numerous washings, is the very large quantity of solution and the great loss of material, which are the consequences. Far better results were obtained by the use of nitric instead of sulphuric acid. The crude precipitate was dissolved in a small quantity of nitric acid, and the deep red solution treated as above, by which a far paler precipitate of basic salt was obtained. The resulting mother-liquor gave on evaporation the complete didymium spectrum and the color of the oxyds prepared from it was brown like that of the original mixed oxyds.

To save repetitions, I will call the crude basic salt N and the precipitate resulting from it Nα. Nα was re-dissolved again in nitric acid and the solution treated as above; it gave a new Nβ, which was easily discernible from N and Nα by its paler color and greater purity. It separated far more readily from the supernatant liquid than N and Nα and was more easily washed out.

The mother-liquor from Nβ examined with the spectroscope still indicated the presence of didymium, and Nβ itself yielded a yellowish white ceroso-ceric oxyd, in which *traces* of didymium were still perceptible.

A portion of Nβ was converted into sulphate and this was re-crystallized six times, the mother-liquor being always separated at each operation. The crystallizations were obtained by a very slow evaporation of the liquid, and I observed that the forms of the crystals had materially changed. As already stated, the still impure sulphate always gave thin slender crystals, while now, after repeated evaporations and crystallizations, no other but small octahedral forms were produced.

From this salt several new determinations of the equivalent were made.

The pulverized salt was dried over sulphuric acid and the analyses conducted as already described:

β_1. 1·4327 grs. gave 0·2733 grs. water and 0·69925 grs. of ceroso-ceric oxyd, corresponding with 0·66491 grs. cerous oxyd;

β_2. 1·5056 grs. gave 0·2775 grs. water and 0·7405 grs of ceroso-ceric oxyd, corresponding with 0·70413 grs. of cerous oxyd; 0·8816 grs. of the ceroso-ceric oxyd from β_1 and β_2 gave 0·8383 grs. cerous oxyd.

β_3. 1·44045 grs. gave 0·2710 grs. water and 0·7052 grs. ceroso-ceric oxyd, corresponding with 0·67044 grs. cerous oxyd. 0·5102 grs. of the ceroso-ceric oxyd gave 0·48505 grs. cerous oxyd.

These results give for the anhydrous sulphate:

	β_1	β_2	β_3	Mean.
Cerous oxyd,	57·349	57·335	57·329	57·338
Sulphuric acid,	42·651	42·665	42·671	42·662
	100·000	100·000	100·000	100·000
Equivalent,	45·784	45·754	45·741	45·760

The hydrous sulphate has the composition:

	β_1	β_2	β_3	Mean.
Cerous oxyd,	46·409	46·767	46·544	46·573
Sulphuric acid,	34·515	34·802	34·642	34·653
Water,	19·076	18·431	18·814	18·774
	100·000	100·000	100·000	100·000

From these analyses it becomes evident that the composition of this hydrous sulphate differs from that previously described and that it can be expressed by the formula $2(CeO, SO_3)+5HO$, which would give:

Cerous oxyd,	46·241
Sulphuric acid,	34·406
Water,	19·353

The equivalents resulting from these analyses differ very much from those previously obtained, but it is hardly possible that the separation of didymium *alone* can be the cause of the reduction from 46·187 to 45·760. Bunsen's and Rammelsberg's equivalents 46·058 and 46·072 were certainly made with cerium salts *free* or *almost free* from didymium. The salt which gave 45·760 still contained a trace of this metal.

From all these facts we are led to conclude that the reduction of the equivalent of cerium from 46· to 45·760 is *not* owing to the separation of didymium, but to that of *another foreign* substance.

The mother-liquor and wash-waters from Nβ gave with ammonia a very minute precipitate.

Encouraged by the results obtained by this method of separation, I have continued in the same manner. A portion of Nβ was dissolved in nitric acid, and this solution re-precipitated by boiling water. The new precipitate Nγ was *almost* white. In the mother-liquor the presence of didymium could hardly be detected by the line D, while in the precipitate itself *not a trace* was visible.

The sulphate prepared from Nγ again showed the habitus of the first sulphates and crystallized in slender crystals, which gave the same angles with no new modifications; analysis proved that their composition also was nearly the same. I found that—

1·4684 grs. gave 0·1880 grs. of water and 0·7717 grs. of ceroso-ceric oxyd, which gave 0·7338 grs. of ceroso-oxyd.

The sulphate contains therefore as follows:

	The anhydrous:	The hydrous:
Cerous oxyd,	57·310	49·973
Sulphuric acid,	42·690	37·224
Water,	-----	12·803
	100·000	100·000

The equivalent calculated from this analysis is again lower, being equal to 45·699.

Although the cerous sulphate from which the last determinations had been made was *entirely free* from didymium, still I thought that a repetition of the same mode of purification might lead to a still greater reduction of the equivalent, owing to the removal of the foreign substance above alluded to.

A portion of Nγ was therefore treated as usual, and produced the basic salt Nδ.

After washing it was perfectly white, though otherwise in appearance similar to N, Nα, Nβ and Nγ.

The oxyds obtained, both from the oxalate, prepared from the mother-liquor, and that from the basic salt, were white. In neither could the least trace of didymium be detected. The sulphate prepared from Nδ after repeated and very careful recrystallizations, had the habitus of the first sulphates and gave on analysis the following results:

1·3756 grs. gave 0·1832 grs. water and 0·7186 grs. of ceroso-ceric oxyd, yielding 0·68318 grs. of cerous oxyd.

These results would give for:

	The crystallized salt.	The anhydrous salt.
Cerous oxyd,	49·664	57·294
Sulphuric acid,	37·018	42·706
Water,	13·318	-----
	100·000	100·000

The equivalent was again reduced by this operation, which now makes it equal to 45·664, which number must be considered as the equivalent of the purest cerium, which has as yet been prepared.

Further investigations will be needed to ascertain, whether a continued repetition of the same operation can reduce the equivalent of cerium to a still lower number.

ART. IX.—*Laws of Botanical Nomenclature adopted by the International Botanical Congress held at Paris in August, 1867; together with an Historical Introduction and Commentary.* By ALPHONSE DECANDOLLE. Translated from the French.

*** We reprint, from the English Translation, published by L. Reeve & Co., (London, 1868, pp. 72, 8vo) the

LAWS OF BOTANICAL NOMENCLATURE ADOPTED BY THE CONGRESS.

General considerations and leading principles.

ARTICLE 1. Natural History can make no real progress without a regular system of nomenclature, acknowledged and used by a large majority of naturalists of all countries.

Art. 2. The rules of nomenclature should neither be arbitrary, nor imposed by authority. They must be founded on considerations clear and forcible enough for every one to comprehend and be disposed to accept.

Art. 3. The essential point in nomenclature is to avoid or to reject the use of forms, or names, that may create error or ambiguity, or throw confusion into science.

Next in importance is the avoidance of any useless introduction of new names.

Other considerations, such as absolute grammatical correctness, regularity or euphony of names, a more or less prevailing custom, respect for persons, etc., notwithstanding their undeniable importance, are relatively accessory.

Art. 4. No custom contrary to rule can be maintained if it leads to confusion or error. When a custom offers no serious inconvenience of this kind, it may be a motive for exceptions, which we must, however, abstain from extending or imitating. In the absence of rule, or where the consequences of rules are questionable, established custom becomes law.

Art. 5. The principles and forms of nomenclature should be as similar as possible in botany and in zoology.

Art. 6. Scientific names should be in Latin. When taken from another language, a Latin termination is given to them, except in cases sanctioned by custom. If translated into a modern language, it is desirable that they should preserve as great a resemblance as possible to the original Latin names.

Art. 7. Nomenclature comprises two categories of names :—1. Names, or rather terms, expressing the nature of the groups comprehended one within another. 2. Names particular to each of the groups of plants or animals that observation has made known to us.

On the manner of designating the nature and subordination of the groups that constitute the Vegetable Kingdom.

Art. 8. Every individual plant belongs to a species (*species*), every species to a genus (*genus*), every genus to an order (*ordo, familia*), every order to a cohort (*cohors*), every cohort to a class (*classis*), every class to a division (*divisio*).

Art. 9. In many species we distinguish likewise *varieties* and *variations*, and in some cultivated species, modifications still more numerous; in many genera *sections*, in many orders *tribes*.

Art. 10. Finally, if circumstances require us to distinguish a greater number of intermediate groups, it is easy, by putting the syllable *sub* before the name of the group, to form subdivisions of that group; in this manner suborder (*subordo*) designates a group between an order and a tribe, subtribe (*subtribus*), a group between a tribe and a genus, etc. The *ensemble* of subordinate groups may thus be carried, for uncultivated or spontaneous plants only, to twenty degrees, in the following order:—

Regnum vegetabile.
Divisio.
Subdivisio.
Classis.
Subclassis.
Cohors.
Subcohors.
Ordo.
Subordo.
Tribus.
Subtribus.
Genus.
Subgenus.
Sectio.
Subsectio.
Species.
Subspecies (vel Proles, Angl. *Race*).
Varietas.
Subvarietas.
Variatio.
Subvariatio.
Planta.

Art. 11. The definition of each of these names of groups may vary, in a certain degree, according to individual opinion and the state of science, but their relative rank, sanctioned by custom, must not be inverted. Any classification containing inversions, such as the division of genera into orders, or of species into genera, is inadmissible.

Art. 12. The fertilization of one species by another gives rise to a hybrid (*hybridus*); that of a modification or subdivision of a species by another modification of the same species produces a half-breed (*mistus, mule* of florists).

Art. 13. The arrangement of species in a genus or in a sub-

division is made by means of typographical signs, letters, or figures. Hybrids are classed after one of the species from which they originate, with the sign × prefixed to the generic name.

The rank of subspecies under species is marked by letters or figures; that of varieties by the series of Greek letters α, β, γ, etc. Groups below varieties and half-breeds (mule of florists) are indicated by letters, figures or typographical signs, according to the will of the author.

Art. 14. Modifications of cultivated species should, where possible, be classed under the wild or spontaneous species from which they are derived.

For this purpose the most striking are treated as subspecies, and when constant from seed, they are called races (*proles*).

Modifications of a secondary order take the name of varieties, and if there be no doubt as to their almost constant heredity by seed, they are termed subraces (*subproles*).

Modifications of minor importance, more or less comparable to subvarieties, variations or subvariations of uncultivated species, are indicated according to their origin in the following manner:—1. *Satus* (seedling; Gall. semis; Germ. Sämling), for a form obtained from seed. 2. *Mistus* (blending;* Gall. métis; Germ. Blendling), for a form arising from cross-fertilization in a species. 3. *Lusus* (sport; Germ. Spielart), for a form originating from a leaf-bud or from any other organ, and propagated by division.

On the manner of designating each group or association of plants.

Section 1. *General Principles.*

Art. 15. Each natural group of plants can bear in science but one valid designation, namely, the most ancient, whether adopted or given by Linnæus, or since Linnæus, provided it be consistent with the essential rules of nomenclature.

Art. 16. No one ought to change a name or a combination of names without serious motives, derived from a more profound

* Since the meeting of the Congress, the author of this pamphlet has, together with the translator, turned his attention to the choice of a significant English term for the French *métis*. The word *blending* does not perhaps indicate quite clearly enough the existence of a mixture, and does not allude to its nature. The term *half-breed*, used by agriculturists, appears to answer much better to the sense *métis; breed* precisely implying a *race*, and *half-breed* the mixture of two races. It may, however, likewise be suggested that the shortness of the French word *métis*, analogous to the Spanish *mestizo*, and evidently derived from the Latin *mistus*, or *mixtus*, will perhaps induce English botanists to adopt it, together with the word half-breed. The latter is undoubtedly more expressive, but metis has over it the advantage of being intelligible in several tongues. The term *mule*, as applied to the mixture of varieties of races, is in constant use amongst English florists; but is too obviously erroneous to be sanctioned by scientific writers. (*Translator.*)

knowledge of facts, or from the necessity of relinquishing a nomenclature that is in opposition to essential rules (art. 3, first paragraph, 4, 11, 15, etc.: see sect. 6).

Art. 17. The form, the number, and the arrangement of names depend upon the nature of each group, according to the following rules.

Section 2. *Nomenclature of the different kinds of Groups.*

§ 1. *Names of Divisions and Subdivisions, Classes and Subclasses.*

Art. 18. The names of divisions and subdivisions, of classes and subclasses, are drawn from their principal characters. They are expressed by words of Greek or Latin origin, some similarity of form and termination being given to those that designate groups of the same nature (Phanerogams, Cryptogams; Monocotyledons, Dicotyledons, etc.).

Art. 19. Among Cryptogams, the old family names, such as *Filices, Musci, Fungi, Lichenes, Algæ*, may be used for names of classes and subclasses.

§ 2. *Names of Cohorts and Subcohorts.*

Art. 20. Cohorts are designated preferably by the name of one of their principal Orders, and as far as possible with a uniform termination.

Subcohorts (rarely used) may be designated in the same manner.

§ 3. *Names of Orders and Suborders, of Tribes and Subtribes.*

Art. 21. Orders (*Ordines, Familiæ*) are designated by the name of one of their genera, with the final *aceæ* (*Rosaceæ*, from *Rosa*; *Ranunculaceæ*, from *Ranunculus*, etc.).

Art. 22. Custom warrants the following exceptions:—

(1.) When the Latin name of the genus from which is taken that of the Order ends in *-ix* or *-is* (genitive *-icis* or *-idis*), the termination *-iceæ*, or *-ineæ*, or *-ideæ* is admitted (*Salicineæ*, from *Salix; Tamariscineæ*, from *Tamarix; Berberideæ*, from *Berberis*).

(2.) When the genus from which the name is derived has an unusually long name, no tribe in the Order taking its appellation after the same genus, the termination in *-eæ* is admitted (*Dipterocarpeæ*, from *Dipterocarpus*).

(3.) Some large Orders, named long since, have retained the exceptional names under which they are generally known (*Cruciferæ, Leguminosæ, Guttiferæ, Umbelliferæ, Compositæ, Labiatæ, Cupuliferæ, Coniferæ, Palmeæ, Gramineæ*, etc.).

(4.) An old generic name, which has become that of a section or of a species, may be preserved as the foundation of that of the Order (*Lentibularieæ*, from *Lentibularia; Hippocastaneæ*,

from *Æsculus Hippocastanum; Caryophylleæ*, from *Dianthus Caryophyllus*, etc.).

Art. 23. The names of suborders (*subordines, subfamiliæ*) are derived from the name of one of the genera that form part of them, with the final *-eæ*.

Art. 24. The names of tribes and subtribes are taken from that of one of the genera included in the group, with the final *-eæ* or *-ineæ*.

§ 4. *Names of Genera and of Divisions of Genera.*

Art. 25. Genera, subgenera, and sections, receive names, commonly substantive, which may be compared to our own proper family names.

These names may be derived from any source whatsoever, and may even be arbitrarily imposed, under the restrictions mentioned further on.

Art. 26. A name may be given to subsections, as well as to inferior generic subdivisions; or these may simply be indicated by a number, or by a letter.

Art. 27. When the name of a genus, subgenus, or section is taken from the name of a person, it is composed in the following manner:—

The name cleared of titles or of any accessory particle, takes the final *-a* or *-ia*.

The spelling of the syllables unaffected by this final, is preserved without alteration, even with letters or diphthongs now employed in certain languages, but not in Latin. Nevertheless *ä*, *ö*, and *ü*, of the German language become *æ*, *œ*, and *ue*, whilst *é* and *è* of the French language become *e*.

Art. 28. Botanists who have generic names to publish show judgment and taste by attending to the following recommendations:—

(1.) Not to make names too long or difficult to pronounce.

(2.) To give the etymology of each name.

(3.) If they have formerly made a name that has not been accepted, not to establish another genus under the same name, particularly in the same Order, or in a neighboring one.

(4.) Not to dedicate genera to persons in all respects strangers to botany, or at least to natural history, nor to persons quite unknown.

(5.) Not to draw names from barbarous tongues, unless those names be frequently quoted in books of travel, and have an agreeable form that adapts itself readily to the Latin tongue, and to the tongues of civilized countries.

(6.) If possible, by the composition or the termination of the word, to call to mind the affinities or the analogies of the genus.

(7.) To avoid adjective nouns.

(8.) Not to give to a genus a name whose form is more properly that of a section (*Eusideroxylon*, for example).

(9.) To avoid taking up names that have already been used, but have not been approved, and applying them to genera different from the former, unless it be wished again to dedicate a genus to a botanist; but, even in this case, it is desirable—1, that the nullity of the first genus should be unquestionable; 2, that the order in which it is proposed to re-establish the name be quite distinct from the former one.

(10.) To avoid making choice of names used in zoology.

Art. 29. Botanists constructing names for subgenera or for sections will do well to attend to the recommendations of the foregoing article, as well as to these :—

(1.) Give, where possible, to the principal division of a genus a name that, by some modification or addition, may call the name of the genus to mind (for instance, *eu* at the beginning of the name, when it is of Greek origin; *-astrum*, *-ella*, at the end of a name, when Latin, or any other modification consistent with the rules of grammar and the usages of the Latin language).

(2.) Avoid calling a section by the name of the genus it belongs to, with the final *-oides* or *-opsis;* give, on the contrary, the preference to this final for a section having some resemblance to another genus, by adding, in that case, *-oides* or *-opsis* to the name of that other genus, if it be of Greek derivation, so as to form the name of the section.

(3.) Avoid taking, as a sectional name, one already in use as such, in another genus, or which is that of a genus.

Art. 30. When it is required to express the name of a section, together with a generic name and that of a species, the name of the section is put between the two others in a parenthesis.

§ 5. *Names of Species, of Hybrids, and of Subdivisions of Species, either spontaneous or cultivated.*

Art. 31. All species, even those that singly constitute a genus, are designated by the name of the genus to which they belong, followed by a name termed specific, more commonly of the adjective kind.

Art. 32. The specific name ought, in general, to indicate something of the appearance, the characters, the origin, the history, or the properties of the species. If derived from the name of a person, it usually calls to mind the name of him who discovered or described it, or who may have been otherwise concerned with it.

Art. 33. Names of persons used as specific names have a genitive or an adjective form (*Clusii* or *Clusiana*). The first is used when the species has been described or distinguished by the botanist whose name it takes; in other cases the second form is preferred. Whatever be the form chosen, every specific name derived from the name of a person should begin with a capital letter.

Art. 34. A specific name may be an old generic name, or a substantive proper name. It then takes a capital, and does not agree with the generic name (*Digitalis Septrum, Coronilla Emerus*).

Art. 35. No two species of the same genus can bear the same specific name, but the same specific name may be given in several genera.

Art. 36. In constructing specific names, botanists will do well to give attention to the following recommendations:—

(1.) Avoid very long names, as well as those that are difficult to articulate.

(2.) Avoid names that express a character common to all, or to almost all the species of a genus.

(3.) Avoid names designating little known or very limited localities, unless the species be very local.

(4.) Avoid, in the same genus, names too similar in form,—above all, those that only differ in their last letters.

(5.) Readily adopt unpublished names found in travellers' notes or in herbaria, unless they be more or less defective (see Art. 17).

(6.) Avoid names that have been already used in the genus, or in some nearly allied genus, and have become synonyms.

(7.) Name no species after any one who has neither discovered, nor described, nor figured, nor studied it in any way.

(8.) Avoid specific names composed of two words.

(9.) Avoid specific names having, etymologically, the same meaning as the generic name.

Art. 37. Hybrids whose origin has been experimentally demonstrated are designated by the generic name, to which is added a combination of the specific names of the two species from which they are derived, the name of the species that has supplied the pollen being placed first with the final *i* or *o*, and that of the species that has supplied the ovulum coming next, with a hyphen between (*Amaryllis vittato-reginæ*, for the Amaryllis proceeding from *A. reginæ*, fertilized by *A. vittata*.

Hybrids of doubtful origin are named in the same manner as species. They are distinguished by the absence of a number, and by the sign × being prefixed to the generic name (× *Salix capreola*, Kern.).

Art. 38. Names of subspecies and varieties are formed in the same way as specific names, and are added to them according to relative value, beginning by those of the highest rank. Half-breeds (*mules* of florists) of doubtful origin are named and ranked in the same manner.

Subvarieties, variations, subvariations of uncultivated plants may receive names analogous to the foregoing, or merely numbers or letters, for facilitating their arrangement.

Art. 39. Half-breeds (*mules* of florists) of undoubted origin are designated by a combination of the two names of the subspecies, varieties, subvarieties, etc., that have given birth to them, the same rules being observed as in the case of hybrids.

Art. 40. Seedlings, half-breed of uncertain origin, and sports should receive from horticulturists fancy names in common language, as distinct as possible from the Latin names of species or varieties. When they can be traced back to botanical species, subspecies, or variety, this is indicated by a succession of names (*Pelargonium zonale*, Mrs. Pollock).

Section 3. *On the Publication of Names, and on the Date of each Name or Combination of Names.*

Art. 41. The date of a name or of a combination of names is that of its actual and irrevocable publication.

Art. 42. Publication consists in the sale or the distribution among the public of printed matter, plates, or autographs. It consists, likewise, in the sale or the distribution, among the leading public collections, of numbered specimens, accompanied by printed or autograph tickets, bearing the date of the sale or distribution.

Art. 43. The communication of new names in a public meeting, and the placing of names in collections or in gardens open to the public, do not constitute publication.

Art. 44. The date put to a work is presumed to be correct, till there is evidence to the contrary.

Art. 45. A species is not looked upon as named unless it has a generic name as well as a specific one.

Art. 46. A species announced in a work under generic and specific names, but without any information as to its characters, cannot be considered as being published. The same may be said of a genus announced without being characterized.

Art. 47. Botanists will do well to conform to the following recommendations :—

(1.) To give accurately the date of publication of their works or portions of works, and that of the sale or the distribution of named and numbered plants.

(2.) To publish no name without clearly indicating whether it is that of an Order or of a tribe, of a genus or of a section, of a species or of a variety,—in short, without giving an opinion as to the nature of the group to which the name is given.

(3.) To avoid publishing or mentioning in their works unpublished names which they themselves do not accept, especially if the authors of such names have not expressly authorized them to do so. (See Art. 36, 5.)

Section 4. *On the Precision to be given to Names by the Quotation of the Author who first published them.*

Art. 48. For the indication of the name or names of any group to be accurate and complete, it is necessary to quote the author who first published the name or combination of names in question.

Art. 49. An alteration of the constituent characters, or of the circumscription of a group, does not warrant the quotation of another author than the one that first published the name or combination of names. When the alteration is considerable, the words: *mutatis charact.*, or *pro parte*, or *excl. syn.*, *excl. sp.*, *excl. var.*, or any other abridged indication, are added to the quotation of the original author, according to the nature of the changes that have been made, and of that group that is dealt with.

Art. 50. Names published from a private document, such as an herbarium, a non-distributed collection, etc., are individualized by the addition of the name of the author who publishes them, notwithstanding the contrary indication that he may have given. In like manner names used in gardens are individualized by the mention of the author who first publishes them.

The herbarium, the collection, or the garden, should be fully quoted in the text. (*Lam. ex Commers. ms. in Herb. Par.; Lindl. ex horto Lodd.*)

Art. 51. When a group is moved, without alteration of name, to a higher or lower rank than that which it held before, the change is considered equivalent to the creation of an entirely new group, and the author who has effected the change is the one to be quoted.

Art. 52. Authors' names put after those of plants are abbreviated, unless they be very short.

For this purpose, preliminary particles or letters that do not, strictly speaking, form part of the name, are suppressed, and the first letters are given without any omission whatsoever. If a name of one syllable is long enough to make it worth while to abridge it, the first consonants only are given (*Br.* for Brown);

if the name has two or more syllables, the first syllable and the first letter of the following one are taken ; or, the two first, if they are both consonants (*Juss.* for De Jussieu ; *Rich.* for Richard).

When it is found necessary to give more of a name, for the sake of avoiding confusion between names beginning with the same syllables, the same system is to be followed. For instance, two syllables are given, together with the one or two consonants of the third ; or else one of the last characteristic consonants of the name is added (*Bertol.* for Bertoloni, so that it may be distinguished from Bertero ; or *Michx.* for Michaux, to prevent confusion with Micheli). Christian names or accessory designations, serving to distinguish two botanists of the same name, are abridged in the same way (*Adr. Juss.* for Adrien de Jussieu, *Gærtn. fil.* or *Gærtn. f.* for Gærtner son).

When it is settled custom to abridge a name in another manner, it is best to conform to it (*L.* for Linnæus, *St.-Hil.* for Saint-Hilaire).

Section 5. *On Names that are to be retained where a Group is divided, remodelled, transferred, or moved from one rank to another, or when two Groups of the same rank are united.*

Art. 53. An alteration of characters, or a revision carrying with it the exclusion of certain elements of a group or the addition of fresh ones, does not warrant a change in the name or names of a group.

Art. 54. When a genus is divided into two or more genera, its name must be retained, and given to one of the chief divisions. If the genus contains a section or some other division which, judging by its name or by its species, is the type or the origin of the group, the name is reserved for that part of it. If there is no such section or subdivision, but one of the parts detached contains, however, a great many more species than the others, it is to that part that the original name is to be applied.

Art. 55. In case two or more groups of the same nature are united into one, the name of the oldest is preserved. If the names are of the same date, the author chooses.

Art. 56. When a species is divided into two or more species, if one of the forms happens to have been distinguished earlier than the others, the name is retained for that form.

Art. 57. When a section or a species is moved into another genus, when a variety or some other division of a species is given as such to another species, the name of the section, the specific name or that of the division of the species, is maintained, unless there arise one of the obstacles mentioned in Articles 62 and 63.

Art. 58. When a tribe is made into an Order, when a subgenus or a section becomes a genus, or a division of a species becomes a species, or *vice versâ*, the old names are maintained, provided the result be not the existence of two genera of the same name in the Vegetable Kingdom, two divisions of a genus, or two species of the same name in the same genus, or two divisions of the same name in the same species.

Section 6. *On Names that are to be rejected, changed, or altered.*

Art. 59. Nobody is authorized to change a name because it is badly chosen or disagreeable, or another is preferable or better known, or for any other motive, either contestable or of little import.

Art. 60. Every one is bound to reject a name in the following cases:—

(1.) When the name is applied, in the Vegetable Kingdom, to a group that has before received a name in due form.

(2.) When it is already in use for a class or for a genus, or is applied to a division or to a species of the same genus, or to a subdivision of the same species.

(3.) When it expresses a character of an attribute that is positively wanting in the whole of the group in question, or at least in the greater part of the elements it is composed of.

(4.) When it is formed by the combination of two languages.

(5.) When it is in opposition to the rules laid down in Section 5.

Art. 61. The name of a cohort, subcohort, Order, suborder, tribe, or subtribe, must be changed if taken from a genus found not to belong to the group in question.

Art. 62. When a subgenus, a section, or a subsection passes as such into another genus, the name must be changed if there is already, in that genus, a group of the same rank, under the same name.

When a species is moved from one genus into another, its specific name must be changed if it is already borne by one of the species of that genus. So likewise when a subspecies, a variety, or some other subdivision of a species is placed under another species, its name must be changed if borne already by a form of like rank of that species.

Art. 63. When a group is transferred to another, keeping there the same rank, its name will have to be changed if it leads to misconception.

Art. 64. In the cases foreseen in Articles 60, 61, 62, 63, the name to be rejected or changed is replaced by the oldest admissible one existing for the group in question; in the absence of this, a new one is to be made.

Art. 65. The name of a class, of a tribe, or of any other group above the genus, may have its termination altered so as to suit rule or custom.

Art. 66. When a name derived from Latin or Greek has been badly written or badly constructed, when a name derived from that of a person has not been written consistently with the true spelling of that name, or when a fault of gender has carried with it incorrect terminations of the names of species or of their modifications, every botanist is authorized to rectify the faulty names or terminations, unless it be a question of a very ancient name current under its incorrect form. This right must be used reservedly, especially if the change is to bear upon the first syllable, and, above all, upon the first letter of the name.

When a name is drawn from a modern language, it is to be maintained just as it was made, even in the case of the spelling having been misunderstood by the author, and justly deserving to be criticized.

Section 7. *On Names of Plants in Modern Languages.*

Art. 67. Latin scientific names, or those that are immediately derived from them, are used by botanists preferably to names of another kind, or having another origin, unless these are very intelligible and in common use.

Art. 68. Every friend of science ought to be opposed to the introduction into a modern language of names of plants that are not already there, unless they are derived from a Latin botanical name that has undergone but a slight alteration.

Editorial Remarks and Suggestions.

We have reprinted this code in full, so that American naturalists generally may be informed by it, and contribute their part, if so disposed, to the discussion which probably is hardly yet closed. We commend to their attention the entire publication, issued by L. Reeve & Co. (at 2*s.* 6*d.* sterling), with its interesting Preliminary Notice, Historical Introduction, and the elaborate Commentary which of itself occupies more than half of the pamphlet. The considerable space which the code alone occupies in our restricted pages prevents any extended commentary of our own. It seems to be generally understood that the reference of this subject to the recent Botanical Congress at Paris was in some sort the result of a criticism made in this Journal (for January, 1867) upon the course followed in a matter of nomenclature by a valued contributor to the latest issued vol-

ume of DeCandolle's Prodromus. The innovation had to be the more pointedly condemned because the work of a most excellent botanist, incorporated into the standard publication of the time, and also the culmination of a tendency for a long while manifest in various quarters; but which, although commonly inspired by justifiable motives, and even claiming the highest accuracy, needed only to be consistently carried out in practice to show its harmfulness and ensure its reprobation. The objectionable plan is explicitly condemned in the present code (Art. 48, 49, 53), both in the original draught by DeCandolle for presentation to the Parisian Congress, and as adopted by that body.

The whole code as here printed, after careful discussion and revision in committee, and in several sittings of the Congress, was submitted to a final vote, in which the "following decision was carried all but unanimously, and with manifest satisfaction, by about a hundred botanists of all countries," viz: "That these Laws, as adopted by this assembly, shall be recommended as the best guide for nomenclature in the Vegetable Kingdom."

The few dissenting voices were probably given mainly against Art. 48, &c., and in reference to the long debated point as to the name which should be cited as authority for a species transferred from its original genus to some other. Whether, for example, if we adopt Pursh's genus *Chimaphila* we shall write "*C. maculata* Pursh," or "*C. maculata L.*", with or without an added "sp.", or "*sub Pyrola*," or whatever else may be devised for incorporating synonymy or history with the binomial appellation and the authority for it. The code enjoins the orthodox practice, and the commentary, after an extended presentation of the arguments on both sides, ably vindicates the rule, as did Agassiz long ago, in his *Nomenclator Zoologicus*. We maintained the same view in this Journal many years ago, and also recently (March, 1864), and have nothing to add, except to express the hope that the British Association, which allowed its Committee in 1842 to propose the innovation complained of, will at its ensuing meeting reconsider its recommendation. Some of the arguments on the other side are worthy of serious consideration; still we are convinced, as are most botanists of long experience, that the evils of the proposed innovation, in any of the forms suggested, far outweigh its possible advantages.

Upon Art. 15, the commentary properly explains that its terms must not be held as an impediment to quoting Tournefort [as Linnæus himself was accustomed to do] or any other for a generic name made before Linnæus and adopted by him. To decline to recognize generic, any more than specific names

before Linnæus, or even those of his contemporaries whom Linnæus himself cites, may no doubt save some trouble and research; but if the authority of Linnæus be justly deferred to, so may his example.

As to Art. 21, 22, to insist that ordinal names made from generic shall uniformly terminate in *-aceæ*, or at least in *-ineæ* when euphony suggests that form, may be somewhat arbitrary; but we approve the rule as laid down, and wish it were followed whenever no good reason appears to the contrary.

The concluding recommendation under Art. 25, is probably worthy of attention: but Art. 60 declares, by implication, that no generic name in botany is to be discarded because of prior use in zoology. Names in both kingdoms are far too numerous, and the obstacles to free acquaintance with them far too great, to require botanists to look after zoological names, or vice versa. It is quite as much as zoologists can do to avoid the use of the same name in two or more classes of the Animal Kingdom.

It was doubtless an oversight, as the commentary suggests, through which, in Art. 33, specific personal names are *required* to have a genitive form in one case and an adjective form in the other: a recommendation merely must have been intended. It is by no mistake, however, that all such names, as well as substantive proper names of species, are required to be written with a capital letter. Some American zoologists, preferring uniformity to sense or taste, write all specific names whatever with a small initial: but the example has hardly ever been followed in botany. The code omits all mention of geographical specific names, being adjectives, such as *Canadensis*, *Pennsylvanica*, and the like, about which the custom differs in different languages, the English language requiring a capital initial. They have this also in DeCandolle's Prodromus, except in the latest volumes; but there is at present a tendency to drop the capital letter. This is a matter of usage.

We are not prepared to accede to Art. 50, even as explained and qualified in the commentary, without which it would scarcely be fully understood. For instance, there may be no necessity for taking up one of Commerson's names affixed by him to his plants in herbaria; but if taken up, simple verity would seem to require this botanist's name to be cited. We should feel bound to write "*Flacourtia* Commerson" although published by L'Heritier or Jussieu, who probably supplied the character. The rule as proposed would apply to names communicated with manuscript characters by one botanist to another, as well as to named specimens. Now, no botanist is bound to do the work of publication for another; but if he chooses to do so, the maxim *qui facit per alias*, etc., must

fairly apply, and succeeding writers should not be required to take the godfather for the father. If we rightly understand the editor, he proposes that we should write *Eulophus*, *Leptocaulis*, and *Trepocarpus*, DC., although the elder DeCandolle, accepting these names with the specimens from Nuttall, scrupulously attributes them to "*Nutt. in litt.*" To us all such names, which the elder DeCandolle has, at his own discretion, published for Nuttall, are of "*Nutt. in DC. Prodr.*" &c.

The Linnæan canon that *hybrid* names, part Greek part Latin, are inadmissible, having properly been kept up (Art. 60, 5,) M. DeCandolle, in the commentary, calls attention to its habitual violation by botanists in the case of personal names, supposed to be Latinized, and which at least are not Greek, to which the Greek *-oides*, *-ides*, or *-opsis*, is added. In his original draft he inclined to reject all such names, hardly considering what numerous changes would be involved; in the present commentary he concedes that, as they are not really Latin with Greek endings, they must be permitted to stand, though faulty. It would surely never do to change *lobelioides*, *rapunculoides*, *campanuloides* (Italian and Greek), *ranunculoides* (good Latin and Greek), *scirpoides* and the like, so freely used by all botanists, from Linnæus to the present day: even A. DeCandolle himself, who hopes he has none of the sort to reproach himself with, gave to a section of *Wahlenbergia* the name of *Lobelioides*. As to specific names formed of *-oides* added to personal generic names of modern and unclassical origin, they could not now be dispensed with; so we must needs insist, with such reason as we may, that the main word is not really Latinized but Grecified; while in case of real Latin words the Latin form of adjunct is not only the proper one but often the more euphonious,—e. g. *ranunculina*, *scirpina*, &c.

This digest, as a whole, is to be highly commended, and it cannot fail to be useful. Its greatest value is this, that it does not make, but only declare, the common law of botanists. Our *Phœnogamous* botanists in this country did not need it in the way of correction. Some of the *Cryptogamists* do, and many zoologists.

The English translation is by Dr. Weddell, who states that he has adhered as literally as possible to the original text. In some parts of it the neat French might possibly have been rendered in more terse and idiomatic English with no sacrifice of clearness or accuracy. A. G.

Art. X.—*On the Sulphates of Oxyd of Antimony;* by W. P. Dexter.

The various degrees of saturation of acids with the basic oxyds have been considered, either in general as different classes of *salts*, or have been studied in detail, as combinations of the individual bases. The recent Memoir of Hr. Schultz, of Berlin,* has added largely to the number of compounds known as acid salts. In a work now nearly finished, I hope to show that, of the alum-forming bases, the sulphates of alumina and sesquioxyd of chrome, are capable of combining with an equivalent of hydrated sulphuric acid; that these acid-sulphates stand in close connection with the so-called double salts of the neutral sulphates of these bases; and that they may be regarded as compound acids, of which the double sulphates are the derivative salts. With the view of extending this inquiry to the salts of an oxyd of similar composition, but of a different class, the following examination of the combinations of sulphuric acid with oxyd of antimony was undertaken. No compound was here found analogous to the acid-sulphates of the alum bases; as no salt of oxyd of antimony is known which has the composition of the alums. These compounds have been previously investigated by Brandes, and more recently, and with somewhat different result, by M. Péligot. My own conclusions agree, as will be seen, with those of the German chemist; but are given with hesitation, from experience of the difficulties with which the preparation of these bodies is attended.

For the purpose of demonstrating their existence, and examining their form under the microscope, the salts are easily made by boiling oxyd of antimony or Algaroth powder with dilute sulphuric acid, until the water of the acid is expelled. The bisulphate remains as a white sandy powder, while the concentrated acid deposits on cooling acicular crystals of the ter-sulphate or neutral salt. By the action of hot water, these are converted into minute crystals of the di-sulphate. If the concentration of the acid have not been carried so far, intermixed with, or in place of, the bisulphate will be found crystals of an intermediate salt, of different form: and the liquid, if allowed to attract moisture from the air, deposits still other crystalline compounds, one of which contains equal equivalents of acid and base.

These are the salts which I have succeeded in obtaining in a sufficiently pure state for analysis. They are all crystalline,

* Pogg. Ann., cxxxiii, 137.

dissolve readily in hydrochloric acid, and, with the exception of the disulphate, are decomposed by the action of water. To free them from the adhering acid liquid, they were left for a considerable time upon a porous earthen plate, protected from moisture by a glass containing a vessel of concentrated sulphuric acid. For the plates nothing was here to be found better than the red earthen saucers upon which flower-pots are placed. I had also flat discs made of the same ware, between which the salts, when partially dried, were forcibly pressed by means of a steel screw. The plates, before use, were heated, first in an oven, and then over a large gas flame, or an anthracite fire, and left to cool in a close vessel, over sulphuric acid.

For analysis the salts were dissolved in hydrochloric acid, tartaric added so that the solution could be largely diluted without precipitation, and the antimony thrown down by sulphydric acid: the sulphuric acid was then determined in the filtrate as sulphate of baryta. If, on the contrary, the sulphuric acid be precipitated before the separation of the antimony, a sulphate of baryta is obtained, which after ignition is colored, and retains traces of the metal, that cannot be wholly removed by digestion with dilute hydrochloric acid. All the tartaric acid of commerce, which I have examined, contains sulphuric acid; digestion of the solution in alcohol with a little carbonate of baryta removes the acid, but the tartrate of baryta is not quite insoluble in the alcoholic liquid. With carbonate of lime, no better result was obtained. Through the kindness of Mr. Melvin, druggist of this city, I received a supply of tartaric acid, in large crystals, which were quite free from sulphuric acid and all metallic impurity.

The precipitated sulphid of antimony was collected on a weighed filter, and dried at the temperature of boiling water; from its weight the quantity of the metal or oxyd was calculated. As the antimony was in the state of oxyd, and no nitric acid, oxyd of iron, or other substance capable of decomposing the sulphydric acid, was present, an excess of sulphur in the precipitate was not to be feared. It has been asserted that the tersulphid of antimony retains at 100° C. a quantity of water, not amounting to one p. c., and requiring for its expulsion a temperature above 200°, by which the sulphid is converted into the black, crystalline modification. To determine the precise amount of the error from this source, as well as from the possible presence of uncombined sulphur, the sulphid, after remaining many hours in the water bath, and until its weight varied, at most, one or two tenths of a milligram, was heated in a covered crucible, in an air bath, to 212°—220°, for half or three quarters of an hour at a time, with the following result:

0·8192	SbS_3	lost	2·1	0·4	0·5
0·5445	"	"	1·	0·3	milligrams,

no constant weight being obtained.

The sulphid was then exposed to the same temperature, in a bulb blown upon a narrow glass tube, while the air was displaced by a slow stream of carbonic acid.

0·8536	lost	0·2	
0·5199	"	0·5	
0·6488	"	0·4	
0·3920	"	0·25	milligrams,

these being all products of different analyses; the sulphid was completely converted into the black modification, and the weight on repeated trial remained unchanged. The error, whatever may be its source, of at most the tenth of one p. c., becomes insignificant when compared with the tenfold greater errors inevitable in the preparation of the salts.

Tersulphate, or Neutral Salt.—Oxyd of antimony and Algaroth powder are dissolved in considerable quantity by hot concentrated sulphuric acid, the latter with disengagement of hydrochloric acid, the solvent power of the acid seeming to increase with its temperature. On cooling, a salt is deposited in slender needles, in such quantity, when the acid is saturated at its boiling point, that the whole becomes a thick semi-fluid magma. The crystals are long, four-sided prisms, with terminal faces, set often upon two opposite sides, alike at both ends of the prism. They seem to belong to the oblique rhombic system. The concentrated acid, in which they have formed, retains so little of the oxyd in solution, at the ordinary temperature, that it remains clear when diluted with water; but by sulphydric acid a slight precipitate is produced. In the acid, diluted with about half its volume of water, the oxyd in the cold is much more soluble.

In the preparation of the salt, the oxychlorid was used in preference to the oxyd, as the latter is not easily obtained, free from alkali; and the acid was heated until all water was expelled, and vapor of hydrated acid abundantly given off. The semi-fluid mass of crystals was brought upon a funnel, the neck of which was imperfectly closed by a glass rod, and they were then further freed from the acid upon the porous plates, as has been described. These operations were performed as rapidly as possible, in frosty winter weather, and in a room which was not heated, and was entered for no other purpose. When dry, the salt formed a mass of fibrous texture, very much resembling asbestos.

My analysis shows this to be the tersulphate, or neutral salt:

1. 0·5933 of the salt gave 0·3648 SbS_3:
2. 0·6792 of the same preparation gave 0·4173 SbS_3, and 0·918 $\dot{B}a\bar{S}$.
3. 0·6413 of another preparation gave 0·3999 SbS_3, and 0·0859 $\dot{B}a\bar{S}$.

	Calculated.	1.	2.	3.
SbO_3	54·94	52·82	52·78	53·58
$3SO_3$	45·06	——	46·41	46·00
	100·00		99·19	99·58

The difference in the numbers found in the analyses, from those given by calculation, is to be ascribed to impurity of the preparations, rather than to analytical errors. It is obviously difficult, by pressure between rigid plates, to remove completely all adherent liquid, and an excess of acid was therefore generally found in the salts thus prepared. That this was in the present case the cause of the discrepancy, will appear when it is considered that the acid which adhered to the salt was hydrated acid, and that its water would be represented in the analysis by a loss. The loss, then, should correspond in amount to the excess of acid obtained; or, reckoned in equivalents as water, should be equal to the equivalents of the acid in excess.

The composition of the salt from the above analyses, taken in equivalents, is

	2.	3.
SbO_3	1·	1·
SO_3	3·22	3·14
HO (loss)	0·25	0·13

The earlier analyses gave

	Brandes.	Péligot.*	
SbO_3	56·4	50·2	44·3
SO_3	43·2	51·9	53·1
	99·6	102·1	97·4

Mr. Péligot considers the salt to contain four atoms of acid, a composition which requires 47·77 SbO_3 to 52·23 SO_3, if the equivalent of antimony be taken, as has been here done, at 122·34.† The question is one of considerable importance; for from the composition which he has assigned to this sulphate, and to the other antimonial compounds described in his Me-

* The requisite data for calculation are given only for the first of the analyses of M. Péligot. If there be not a misprint, there is an error in this calculation, as occurs also in three out of the four analyses of the sulphates of antimony, of which the details are given. If from 1·66 of the salt, 2·22 $\dot{B}a\bar{S}$ were obtained, as stated in the memoir, there were 45·9 p. c. of acid, instead of 51·9.

† Pogg. Ann., c, 563; Proceedings of the Am. Acad., Jan. 1862.

moir, Mr. Péligot infers that the salts of antimony, like those of uranium, depart from the recognized law, according to which oxyds containing three equivalents of oxygen require the same number of atoms of acid to form a neutral salt. The existence of such a sulphate of oxyd of antimony is denied by him. "En effet il ne m'a pas été possible de rencontrer un seul sel contenant ·3 équivalents d'acide combiné avec 1 équivalent d'oxyde d'antimoine; de sorte que pour les sels d'antimoine, de même que pour les sels jaunes d'urane, toutes les formules calculées dans les tables d'équivalents de M. Berzelius représent des sels qui n'existent pas."*

But the neutral salt may be prepared in another way, with a composition agreeing so nearly with that required by theory, as to leave no doubt of its existence. By careful heating, in a crucible, of the oxyd, or oxychlorid of antimony, with sulphuric acid, until the excess of acid is expelled, a white residue is obtained, the weight of which, however, is not quite constant, a minute quantity of acid being continually given off, probably on account of the moisture of the air. To obviate this source of uncertainty, the oxyd, or oxychlorid was put into a bulb blown on the end of a narrow and thick glass tube, bent in the shape of a retort, close to the bulb. The neck was then drawn out so as to end in a point, in which, during the distillation, a drop of acid remained, and deprived of its moisture any air which might pass through it. A platinum crucible, lined with asbestos, served as a bath, and was covered with a sheet of mica, perforated for the passage of the neck, over which asbestos was also heaped. The heat was such as just to cause the acid to distil slowly over, the distillation from between one and two grams of oxychlorid lasting several hours: the temperature was above the melting point of lead. At the end, a minute drop collected in the point, at intervals of from a quarter to half an hour. By too long continuance of the heat the vapor of water-free acid is seen in the tube. The acid in the neck having been driven off, the point was sealed with the blowpipe. The product was a coherent, friable mass, crystalline on the surface to the naked eye.

Of a preparation made from the oxyd, 0·4471 gave 0·2823 SbO_3 and 0·5953 $\dot{B}a\bar{S}$: of a salt made from Algaroth powder, 0·6177 gave 0·3946 SbS_3 and 0·815 $\dot{B}a\bar{S}$: in the hundred,

	Calculated.	1.	2.
SbO_3	54·94	54·24	54·88
SO_3	45·06	45·72	45·31
	100·00	99·96	100·19

* Ann. Ch. Phys., 3d Ser., xx, 297.

Basic Salts.—The basic sulphates of antimony form a series of salts in which the oxyd is combined with two, one, and half an equivalent of acid. Besides these, there appear to be others, only one of which I have examined, and which are probably combinations of these simpler salts. They occur under various and often unexpected conditions; but, in general, the degree of dilution of the acid seemed to have the greatest influence in their production. When oxyd of antimony is boiled with sulphuric acid diluted with about its volume of water, a turbid liquid is obtained, in which, under the microscope, no distinctly crystalline body can be perceived. On continuing the ebullition, when the acid has reached a certain degree of concentration, the liquid, provided more oxyd be present than it can dissolve, becomes suddenly clear from the subsidence of a heavy sandlike body. If the boiling have been stopped as soon as this takes place, the substance will be found under the microscope to consist of flat, rhombic prisms, of considerable size. By continuing the boiling, but for a few seconds, these disappear, without any change of appearance perceptible to the eye; but by the microscope, the prisms are seen to be replaced by octahedral crystals. Generally, however, the prisms are from the first mingled with the octahedral salt, from which it is very difficult in this way to obtain them quite free. By a slight concentration of the acid, as has been said, the octahedra are left perfectly free from the prisms.

These octahedra appear to belong to the regular system, are frequently more or less distorted, but very seldom show any replacement or modification of the crystalline form. The faces are striated, and to these little projecting angles, acting like prisms, is due, it seems to me, the slight amount of color which they exhibit in polarized light. As the liquid in which they have formed cools, crystals resembling those of the neutral sulphate generally separate. To prevent admixture with these, the porous plate upon which they were collected was covered and imbedded in hot sand. In their analysis were obtained—

1. From 1·1663 salt, 0·863 SbS_3 and 1·1815 $\dot{B}a\bar{S}$.
2. From 1·1359 of another preparation, 0·847 SbS_3 and 1·1724 $\dot{B}a\bar{S}$.

	Calculated.	1.	2.
SbO_3	64·65	63·57	63·91
$2SO_3$	35·35	34·79	35·44
	100·00	98·36	99·35

The salt is the bisulphate, and its formula $\dot{S}b\bar{S}_2$.

Mr. Péligot, by the action of fuming sulphuric acid upon

oxyd of antimony, obtained a salt "in the form of small, brilliant crystals," of which he has given the analyses:

SbO_3	63·0	64·3
SO_3	37·1	35·0

and which therefore seem to have been the salt just described. In fact, hydrated sulphuric acid, gently warmed, unites with the oxyd to form this compound, which is then dissolved at a higher temperature, with production of the neutral salt.

In the formation of both the octahedral and prismatic crystals, there appears to be direct conversion of the undissolved oxyd into the salts: they are also deposited from a solution of the oxyd in sulphuric acid of the proper concentration. There is, however, a peculiarity attending their formation. When they have separated from the acid liquid, they can be decomposed by addition of water, and again reproduced by concentrating the liquid. But if by still further evaporation they have been redissolved in the acid, as neutral salt, or if the oxyd be at first dissolved in concentrated acid, and the solution in either case decomposed by water, on evaporation the octahedral crystals will not be obtained, or will be obtained only in small quantity: the separated basic salt redissolves at last completely in the acid. By arresting the evaporation at the proper period, as has been said, octahedral crystals may be deposited from the liquid on cooling, but no conversion of the basic salt into them seems to take place. By decomposing the basic salt with carbonate of soda, and treating the resulting oxyd with dilute acid, the octahedral crystals can be again produced.

Finding it difficult to obtain the salt mentioned as occurring in flat prisms free from the octahedral crystals by concentration of the acid liquid in an open vessel, experiments were made with acid of various degrees of dilution. An acid of sp. gr. greater than 1·6, gave, by boiling with the oxyd, octahedral crystals: at 1·597 the prisms first appeared: at sp. gr. 1·57 the oxyd was converted into prisms free from the other salt, but smaller than those produced by the gradual concentration of the liquid; and at 1·554 the product consisted only of needles. So that the production of the body in question is confined within narrow limits of concentration of the acid. The salt was dried, like the bisulphate, upon a plate surrounded with hot sand.

Of two different preparations

0·624 salt gave	0·4864	SbS_3	and	0·571	$\dot{B}a\bar{S}$: (1)
0·524 " "	0·4097	SbS_3	and	0·479	$\dot{B}a\bar{S}$: (2)

Whence their composition was

	1.	eqvts.	2.	eqvts.
SbO_3	66·97	3	67·17	3
SO_3	31·42	5·16	31·39	5·13
HO (loss)	1·61	1·17	1·44	1·05
	100·00		100·00	

and their formula $\dot{S}b_3\bar{S}_5, \dot{H}$, which requires

SbO_3 - - - - - - -	67·75
SO_3 - - - - - - -	30·86
HO - - - - - - -	1·39
	100·00

The salt is most probably a compound of two atoms of bisulphate, and one of protosulphate, $2\dot{S}b\bar{S}_2 + \dot{S}b\bar{S}, \dot{H}$.

This composition explains the facility with which it is changed by prolonged boiling, and concentration of the liquid into the bisulphate; it being only necessary that the equivalent of water be replaced by one of acid.

The crystals of this salt appear large and well defined, under the microscope with medium powers. They are four-sided prisms, having for their section a rhomb with very unequal angles, and terminated by two or four faces, which, from the flatness of the prisms, are not distinctly visible: they belong apparently to the right rhombic system. Formed by the gradual concentration of the acid, they have always the same form; but by exposure of the liquid, or of a solution of the oxyd in dilute acid, to the air, crystals are obtained of the same general appearance, which seem to be of the oblique rhombic system.

By exposure for several weeks to the air, of the liquid from which the prisms had separated, a fine white powder was deposited, consisting of minute irregular needles, in which, with a power of about 600, no further shape could be made out. The quantity was only sufficient for one analysis, and a subsequent attempt to form them did not succeed. 0·3447 gave 0.2668 SbS_3 and 0·2167 SO_3.

	Calculated.	Found.
SbO_3	74·92	73·89
SO_3	20·48	21·59
HO	4·60	(4·43)
	100·00	100·00

The same salt, without the atom of water, was made by Brandes by the action of alcohol upon the neutral salt. I

have obtained in this way a salt in small needles, but which was not analyzed.

The last of these basic salts, the combination of two atoms of oxyd with one of acid, has been described and analyzed, both by Brandes and by Péligot. It is produced by the decomposition by water of the neutral salt, or its solution in dilute sulphuric acid. Precipitated from a solution, I have found it amorphous, but by standing two or three days in contact with the liquid, it crystallizes in needles. According to Brandes, the amorphous salt loses the greater part of its acid by washing with water. The neutral salt, or rather the magma to which the solution of oxyd of antimony in concentrated acid congeals on cooling, is resolved into minute crystalline needles, when decomposed by warm water, or when by the dilution of the acid sufficient heat is evolved. They subsided readily in the liquid, and could be boiled with repeated portions of water without changing their appearance, or the production of an amorphous substance. When brought upon a filter and washed copiously with boiling water, the filtrate contained constantly a little sulphuric acid and deposited oxyd of antimony on cooling. From the agreement of the result of their analysis with the calculated composition, it would seem that in the crystalline state, this salt is not decomposed, or is but slowly decomposed by hot water. 0·8334 of the salt prepared in this way, and dried by pressure in paper, gave 0·8393 SbS_3 and 0·2735 BaS.

	Calculated.	Found.
$2SbO_3$	85·66	86·52
SO_3	11·71	11·27
HO	2·63	(2·21)
	100·00	100·00

Brandes found in the salt 3 p. c. of water. Péligot obtained it water free, and also with two atoms of water. Heated to 100° it lost one half p. c.; the rest of the water required for its expulsion a temperature above 240°.

The series of the sulphates of antimony resembles those of the earths glucina and zirconia, considered as sesquioxyds. The neutral sulphate of neither of these earths combines with hydrate of sulphuric acid to form an acid sulphate,* and the most basic compound of both contains two equivalents of base to one of acid. In place of a bisulphate, they have salts with three atoms of acid to two of the earths, and no intermediate salt, like that of antimony, has yet been discovered. From

* Zirconia, Berzelius, but perhaps not quite certain—glucina, Berzelius, and my own experiments.

bismuth the antimony series differs in that the salts of the former metal are decomposed by water, according to Heinz and Ruge, into basic salts containing equal equivalents of acid and base; here, also, no immediate salt is yet known. A more important difference lies in the fact that oxyd of bismuth appears to form one, if not two, acid sulphates. I have analyses indicating the existence of compounds of the neutral salt with three atoms of hydrate of sulphuric acid; and also of a salt crystrallizing in beautiful pearly scales, and containing equal equivalents of the neutral sulphates of bismuth and potash. A salt with three equivalents of sulphate of potash has been described by Heinz. The further account of these bodies must be reserved until their analyses have given more trustworthy results.

Boston, April, 1868.

ART. XI.—*On the Secular Variation of the Elements of the Earth's Orbit;* by JOHN L. STOCKWELL. With a plate.

A KNOWLEDGE of the elements of the earth's orbit is of great importance in the discussion of many questions of physics which occupy the attention of the scientific men of the present day. Indeed, there are many important problems, whose solution depends entirely upon the values of these elements; and many others in which these elements are either intimately or remotely connected. As an example, we may refer to astronomical phenomena of eclipses of the sun and moon. Since the intensity of the sun's disturbing force depends, to a certain extent, upon the eccentricity of its orbit, the amount of lunar perturbation depending on the sun's attraction must vary from age to age; sometimes hastening, and at other times retarding the occurrence of such phenomena.

But it is not alone in astronomical phenomena that the changing elements of the earth's orbit have an important influence. For the intensity of the sun's light and heat follows the same law of variation as the force of gravitation; and it is evident that the secular variation of the conditions on which these forces depend, must affect the intensity of the forces themselves, and thus have an important bearing on the development of the vegetable and animal kingdoms. Whether the secular variations of the forces of light and heat, in so far as they depend upon the eccentricity of the earth's orbit, are sufficient to account for the changes which geology shows to have taken place during the ages that are past, we do not purpose now to determine. Nor do we purpose to give the necessary

data for determining the secular variation of the climate of either hemisphere of the earth. It would be necessary, for this purpose, to take into account the secular variation of the precession of the equinoxes, and also of the obliquity of the ecliptic to the terrestrial equator, in order to determine the obliquity and intensity of the sun's rays on any given latitude of the earth's surface. But so far as the earth as a whole is concerned, the only element which it is necessary to take into account, is the eccentricity of the orbit. And the values of this element are given in the following table, at intervals of ten thousand years, together with the longitude of the perihelion of the earth's orbit.

The data and formulas on which this table is based, are given in the *Treatise on the Secular Equations of the Moon's Mean Motion*, which we lately published. The materials used in the preparation of the formulas, are the same as those used in the construction of the *American Ephemeris and Nautical Almanac*, with the exception of the mass of the earth, which has been increased to $\frac{1}{332\,1\,3\,2}$. With those elements and masses we have determined anew the secular variations of the elements of the orbits of the eight principal planets. The constants which we have obtained differ somewhat from those obtained by LeVerrier, in his *Memoir on the Secular Inequalities of the Seven Principal Planets*; not only on account of the disturbing influence of the planet *Neptune*, which had not been discovered at the time of his investigation, but also on account of the improved values of the masses and elements of the other planets. We find, in fact, that the superior limit of the eccentricity of the earth's orbit, which LeVerrier gives as equal to 0·07775, should be reduced to 0·06939; and an increase of the mass of the earth, corresponding to the latest determinations of the solar parallax, would reduce the value of the superior limit still more.

Having thus explained the motives which have determined the computation of the following table, and the authority on which it is founded, it only remains to explain very briefly the accompanying chart and the table on which it is based.

In the *Treatise on Secular Equations*, &c., already referred to, we have given a table and chart, showing the eccentricity of the earth's orbit during the period of a million of years; and the table and chart here given, are merely an extension of that table and chart, over a *preceding* million of years; so that the two tables together extend over a period of two million years. The first date in the following table, therefore, corresponds to 1175566 years before the year 1850, or to 1100000 years before the epoch of the integral, in the *Treatise*

referred to. In the accompanying chart, the perpendicular distance from the line AB, to the curve, shows the value of the eccentricity, at the corresponding dates; the distance of the line A′B′ from the line AB, shows the eccentricity in the year 1850; the line XX′, in like manner, shows the mean value of the eccentricity, or, in other words, the square root of the non-periodic term in the expression of the square of the eccentricity; and lastly, the line A″B″, shows the superior limit of the eccentricity. The unit of abscissas is equivalent to 10000 years; that of the ordinates is equivalent to 0·001.

A simple inspection of the charts indicates a curious relation, that could not be so readily discovered by studying the tabular numbers; and that is, that the points of maxima and minima are approximately repeated at intervals of 1,450,000 years. In other words, if at any epoch, there is a maxima or minima of any given magnitude, in 1,450,000 years before or after that epoch, there will be a corresponding maxima or minima. Referring to the charts for a particular example, we notice that for the abscissa –77, there is a very large maxima, and equal to 0·066 nearly; and if we add 145 units of abscissa to –77, we get +68, and for this abscissa the corresponding ordinate, or the eccentricity, is equal to 0·058. The maxima which immediately precede the ones here referred to, are respectively 0·061 and 0·053. The preceding relation seems to hold good for the twelve points of maxima and minima that are repeated within the period over which the computation extends. The longitudes of the perihelion of the earth's orbit are given, for the purpose of showing the great irregularity in motion of that element, and are referred to the equinox and ecliptic of 1850.

We are not aware that any computation of a similar nature has been performed by any one, nearly to the extent here given. The only one at all similar, which we remember having seen, was published by Croll a few years ago, and was derived from LeVerrier's formula. But the intervals used in his computation were much too long, being 50,000 years, instead of 10,000 years, which we have used in our computation. It is evident, by inspection of the chart here given, that many points of maxima and minima would escape our notice, were we to attempt to chart the curve by means of every fifth ordinate.

It is hoped that the following results may be found serviceable in the discussion of those problems of terrestrial physics, in which solar influence, (whether heat, light, or gravitation,) acts as a controlling agent.

Table showing the Elements of the Earth's Orbit during a period of one Million of Years.

t.	Longitude of Perigee. w'.	Eccentricity. e'.	*t.*	Longitude of Perigee. w'.	Eccentricity. e'.
−1100000	11° 54′	0·02130	−590000	35° 49′	0·03679
1090000	76 12	0·01066	580000	74 6	0·03358
1080000	184 11	0·01150	570000	113 42	0·02826
1070000	246 2	0·02104	560000	159 56	0·01970
1060000	287 10	0·02922	550000	232 42	0·01203
1050000	327 32	0·03397	540000	325 41	0·01628
1040000	8 40	0·03509	530000	20 26	0·02962
1030000	52 40	0·03327	520000	61 19	0·04014
1020000	101 40	0·03043	510000	97 48	0·04892
1010000	155 8	0·02915	500000	132 36	0·05324
1000000	208 31	0·03085	490000	166 28	0·05241
990000	256 41	0·03430	480000	199 42	0·04629
980000	299 12	0·03734	470000	232 30	0·03572
970000	337 57	0·03733	460000	264 49	0·02191
960000	14 16	0·03400	450000	295 44	0·00652
950000	49 32	0·02697	445000	139 8	0·00157
940000	86 8	0·01663	440000	150 53	0·00883
930000	149 7	0·00452	430000	181 53	0·02248
920000	303 11	0·01147	420000	213 21	0·03328
910000	342 13	0·02593	410000	244 47	0·04034
900000	14 42	0·03941	400000	276 15	0·04341
890000	45 44	0·05055	390000	308 2	0·04273
880000	76 12	0·05807	380000	340 32	0·03865
870000	106 22	0·06099	370000	14 37	0·03199
860000	136 17	0·05862	360000	52 16	0·02380
850000	165 48	0·05083	350000	98 47	0·01553
840000	194 7	0·03800	340000	168 15	0·01027
830000	217 25	0·02138	330000	246 16	0·01185
820000	183 19	0·00640	320000	302 18	0·01649
810000	134 54	0·02014	310000	346 5	0·01970
800000	158 20	0·03834	300000	29 38	0·02076
790000	172 38	0·05309	290000	76 43	0·01985
780000	218 5	0·06263	280000	128 9	0·01815
770000	249 35	0·06592	270000	190 28	0·01977
760000	281 39	0·06275	260000	245 20	0·02429
750000	314 22	0·05369	250000	291 30	0·03021
740000	348 7	0·04000	240000	331 41	0·03520
730000	25 2	0·02358	230000	7 54	0·03740
720000	85 51	0·00737	220000	41 15	0·03594
710000	233 49	0·01181	210000	71 30	0·03056
700000	279 9	0·02496	200000	96 11	0·02190
690000	315 6	0·03460	190000	101 36	0·01322
680000	349 43	0·03990	180000	63 47	0·01107
670000	24 42	0·04079	170000	61 29	0·02106
660000	61 24	0·03788	160000	81 16	0·03177
650000	94 17	0·03188	150000	105 41	0·04022
640000	148 35	0·02651	140000	130 55	0·04544
630000	204 37	0·02305	130000	155 39	0·04725
620000	262 47	0·02437	120000	184 52	0·04600
610000	313 18	0·02883	110000	200 31	0·04204
−600000	356 27	0·03318	−100000	219 14	0·03669

Art. XII.—*On some Cretaceous fossil Plants from Nebraska;* by L. Lesquereux.

The plants here described have been obtained and sent for examination by Dr. John LeConte of Philadelphia, and by far the largest number by Dr. F. V. Hayden, director of the geological survey of Nebraska. It is by the direction of Dr. Hayden that this paper is prepared as a summary of a more detailed report made for him, which embraces more complete descriptions, with figures of all the species.

All these plants come from the Cretaceous formation north of Fort Ellsworth, Nebraska, or its vicinity.

A small number of splendid specimens from the same formation, belonging to the Smithsonian Institution and obtained by Prof. B. F. Mudge of Manhattan College, were lately sent to me just in time to be described here as a valuable contribution to the flora of the Cretaceous of America. They have been also figured for Dr. Hayden's report.

1. Fragment of a Fern, probably a *Lygodium*. It is too small for determination, even for description, and is merely figured as the only remains of Fern found among the Cretaceous specimens. The veinlets are obsolete; as far as they can be seen, they appear slightly arched and nearly perpendicular to the medial nerve, which branches above the middle of a narrow linear leaf or part of leaf. The medial nerve is thicker than in any *Lygodium* known to me; but its branching from above the base indicates a division of a linear leaf as it is generally seen in species of this genus.

2. *Pterophyllum Haydenii*, sp. nov.—Three parts of the same plant in three specimens, viz: part of a frond, with a pinna, and a cone. The surface of the frond is rugose, bearing a row of dots which look like the scars of the pinnæ. The pinnæ are linear, short, two inches long, half an inch broad, slightly enlarged in the middle, and a little curved upward, and also slightly attenuated at the base and at the round point. They are marked by linear parallel striæ, preserving the same thickness in their whole length and undivided. The cone is cylindrical, formed of large imbricated apparently round scales placed in spiral around the rachis. From the broken specimens it is not possible to get a good idea of the form of the whole plant. But it is evidently closely related to *Pterophyllum Ernestinæ*, Stiehler (Palæont., vol. v, p. 76, tab. xv), a species represented by the same parts of the plant as ours, and which merely differs by slightly broader, more obtuse, straight pinnæ.

3. *Glyptostrobus gracillimus*, sp. nov.—This species resembles *G. Ungeri* Heer, from the Tertiary of Europe, differing by more slender branches and shorter leaves. The branches are thread-like, much divided, the leaves half embracing at the base and either pointed or slightly obtuse. Some of the branches inflated at the point appear to bear male flowers. One of the numerous specimens covered with branches of this little conifer is traversed by a narrow cylindrical cone, of which a few of the scales only are visible. The scales, rhomboidal in outline but pointed at the four corners, are marked in the middle by an oval dot or scar, from which thin, linear closely approached striæ diverge to the borders. It is very probably the cone of this species.

4. *Sequoia formosa*, sp. nov.—A fine cone referred with some doubt to this genus. It is about two inches long, proportionally narrow, spindle shaped, inflated in the middle, and tapering upward and downward about in the same degree, to the point and to the short pedicle. The rhomboidal scales are bordered by an elevated margo, and marked by diverging wrinkles tending to a round point at the top of the scales. No fossil cone of this kind has been published, except one by Prof. Heer in his Urwelt der Schweitz, p. 310, as the cone of *Sequoia Sternbergii* Heer, from the Tertiary. This is nearly round, obtuse, of a very different form. The scales only are of the same shape.

5. *Phyllocladus subintegrifolius*, sp. nov.—A small obovate leaf, attenuated to a short petiole, abruptly rounded and undulate lobed at top. Its substance is pretty thick, subcoriaceous. The medial nerve is narrow; the lateral veins close together, nearly contiguous, are thin, simple or undivided, a few only appearing inflated or stronger than the others. No fossil plant is related to this. By the form of its leaf and its nervation it much resembles *Phyllocladus asplenifolius* of Tasmania.

6. *Arundo cretaceus*, sp. nov.—Merely two small specimens, representing knots of branches or of roots of an Arundo, as they appear when separated from the stem. They are circular button-like scars, more than half an inch broad, elevated in the center, and marked at the borders and near the center by two parallel rows of verrucose, irregular, mostly round convex papillæ. They resemble the scars of *Arundo Göpperti* Heer, from the Miocene of Switzerland. But as the specimens were picked up, detached from the stem, the specification is somewhat uncertain. There is, nevertheless, from the same locality a specimen representing part of a striated stem, 1½ inch broad, which is referable to an *Arundo* or a *Cyperites*. It shows the

double nervation of the stems of this genus; deep, well marked striæ, separated by four or five close, thin lines, scarcely distinguishable with the naked eye.

7. *Liquidambar integrifolius*, sp. nov.—A well preserved, large, and nearly entire leaf. Its form is about the same as that of the leaves of our *Liquidambar Styraciflua*. It is membranaceous, shining, round in outline, deeply five-lobed, with lobes obtusely pointed and *entire*. The primary, secondary and ultimate reticulation is that of our living *Liquidambar*. The petiole of the leaf is destroyed, but it is evidently surrounded by that small basilar subdivision of the leaf which is remarked in our living species. All the fossil *Liquidambar* but this have the borders dentate or serrulate like the species of our time.

8. *Populus Lancastriensis*, sp. nov.—Leaf of a thin substance, with a deeply marked nervation, broadly cordate, probably acute (the point is destroyed(, borne on a slender petiole. Its borders are entire or slightly undulate; its primary nerves in five like the lateral ones are proportionally slender. It is broader and more deeply cordate at its base than any of the species of *Populus* from the Tertiary, resembling by its form a *Dombeyopsis*.

9. *Populites cyclophylla* (*Populus*) Heer.—Leaves round, entire, with slightly undulate borders. Primary nerves in three attached to the petiole; secondary nerves (4 pairs) nearly opposite, running straight to the borders in preserving nearly the same thickness; angle of divergence 40°.—This is apparently Heer's species: *Populus cyclophylla*, of which a short diagnosis is given in Proceed. of Acad. of Nat. Sciences, Philad., 1858, p. 266. The author remarks that the base is narrowed and the leaf orbicular, a description applicable as well to the following species as to this one. The form of the leaves of this species is similar to that of *Populus Griemana* (Ldg.) from the middle Tertiary of the Rhine; but the nervation is far different.

This and the four following species can not be considered as belonging to the genus *Populus*. They differ not only by the narrowed base descending in a curve to the petiole, but especially by the nervation which is truly craspedodrome, the secondary nerves running up to the borders as in the beach. By the nervation, therefore, their relation is rather with *Platanus* than with *Populus*. But the leaves are all entire, oval, or round, or flabelliform. They belong evidently to a new genus whose relation and characters have not yet been thoroughly ascertained.

10. *Populites elegans*, sp. nov.—This species has larger leaves than the former, and also differs from it by its strong, slightly undulate, more divided secondary nerves, and by its more elongated base and long petiole. The number of the secondary nerves and their angle of divergence are the same.

11. *Populites ovata*, sp. nov.—Leaves ovate in outline, with an obtuse or truncate point; borders undulate, enlarging toward the base and abruptly curved to a pretty long slender petiole. The primary nerves are in three or five; the secondary ones are thin, alternate, distant, few in number, with an angle of divergence of 30°. The ultimate reticulation derived from pretty large square subcontinuous areas is polygonal and small, like that of a *Platanus*.

12. *Populites quadrangularis*, sp. nov.—This leaf is about quadrangular in outline, with obtuse angles and convex borders; the upper part undulate, the lower entire. The petiole and medial nerve are slender, the primary nerves in five, the lowest pair at a short distance from the upper, the secondary nerves numerous, six on each side, running parallel and slightly arched to the borders. The substance of the leaves is pretty thick. The lowest primary nerves, shorter and more slender, run along the borders as in *Populus*.

13. *Populites flabellata*, sp. nov.—A round fan-shaped leaf somewhat abruptly narrowed toward the base, petioled and thin. The borders are slightly crenulate, especially in the lower part of the leaf. The medial nerve, strongly curved to one side, is thick as also the lateral and secondary nerves, which are alternate, pretty close to each other and branching. The veinlets are deeply marked, perpendicular to the nerves and continuous.

14. *Populites Salisburiæfolia*, sp. nov.—The general outline of this leaf is about the same as in the former. It is fan-like also, narrowed to the petiole where the borders are slightly decurrent. Its broadest part is above the middle, and the top, nearly flat, is divided by two deep narrow sinuses, in three obtuse, undulate or slightly crenate lobes. The nervation of this species is that of an *Acer*. The primary nerves in three, from above the base of the leaf, are distinct but narrow; the lateral ones ascend to the top of the lobes in dividing outward; the medial one branching from above the middle in opposite arched divisions, ascends to the slightly notched top of the leaf.

15. *Salix proteæfolia*, sp. nov.—Except that the leaves are smooth or polished, apparently thick and coriaceous, this species so much resembles *Salix tenera* Al. Br., that no difference can be pointed out in these forms. The leaves are lanceolate or linear-lanceolate, merely pointed or tapering upward into an

elongated point; sometimes slightly enlarged near the base and gradually narrowed into a thin petiole, more than half an inch long. The secondary veins rarely visible, ascending under an angle of 40 to 45°, curve near the borders and are separated by shorter intermediate ones. In some of the specimens referred to this species, the substance of the leaves appears thinner and the surface not polished. This difference may be due to the nature of the stone in which the leaves have been imbedded, or there may be two species whose leaves are exactly alike in form and nervation. There is still among the specimens one leaf which, though of the same form, is much smaller, obtusely pointed, with a longer petiole. The nervation is totally obsolete. It may belong to another species.

16. *Betula Beatriciana*, sp. nov.—Leaf enlarged above the middle, obovate in outline, cuneiform to the petiole, tapering upward to a point; unequally simply toothed in its upper part. The nervation, general form and surface of the leaves are those of the genus. There are many fragments of the species. On some specimens the teeth appear somewhat obtuse.

17. *Fagus polycladus*, sp. nov.—An oval, probably obtusely pointed leaf (the point is destroyed), narrowed to the petiole, entire and wavy on the borders, with a narrow medial nerve and very slender, numerous (14 to 16 pair) parallel secondary nerves, ascending under an angle of 40° straight to the borders. The substance of the leaves is thin, its surface polished. From the great number of secondary nerves and their proximity, this species resembles *Fagus Deucalionis* Ung.; but this has dentate borders. By its form and its undulate entire borders, it is like *Fagus sylvatica* S., of our time, merely differing by the number of the veins.

18. *Quercus primordialis*, sp. nov.—This species is of a type which has many representatives in the Tertiary, and which is still found most predominant among our living oaks. Its nearest relation is our *Quercus prinoides* Mich., which it so closely resembles as to be undistinguishable from it by any characters taken from the leaves. The leaf is oblong-lanceolate, taper pointed at both ends, short petioled, with borders regularly dentate, the teeth pointing upward, separated by obtuse sinuses. The medial nerve is sharp and narrow like the secondary nerves (about 14 on each side), which run straight to the sharp point of the teeth under an angle of 40°. The veinlets are clearly marked, perpendicular to the nerves and continuous.

19. *Quercus hexagona*, sp. nov.—There is only one broken specimen of this species. In the middle of the leaf the borders are nearly parallel and entire; above they taper to a point and

are marked by a few strong pointed teeth. Downward they are slightly enlarged just above the base, and hence are attenuated to the petiole, giving thus an hexagonal form to the leaf. The secondary nerves, seven on each side, slightly curve in ascending each to the point of a tooth.

20. *Quercus Ellsworthianus*, sp. nov.—A leaf somewhat like the following, resembling *Quercus Lyellii* Heer, by its oblong oval form and undulate borders; the point is destroyed; the base is narrowed to the petiole. The substance of the leaf is thin and the secondary nerves very slender, camptodrome, sometimes branching near the borders.

21. *Quercus anceps*, sp. nov.—Allied like the former to *Quercus Lyellii* Heer. Leaves coriaceous, ovate-lanceolate, pointed, or short-acuminate, attenuated to the base, with very entire, not undulate borders. Secondary nerves strong, camptodrome, curving near and along the borders; veinlets perpendicular, nearly continuous, mostly branching. The base of the leaf is destroyed.

22. *Quercus semi-alatus*, sp. nov.—The leaves of this species are irregular in form and nervation. The general outline is ovate-lanceolate, obtuse at the base and at the top. It is more extended on one side than on the other, obtusely lobed on one side and merely undulate and entire on the other. Secondary nerves alternate, strong, at variable distances, of various length, craspedodrome and camptodrome, diverging under various angles, with the reticulation of a *Platanus*. The substance of the leaves is pretty thick.

23. *Ficus? rhomboideus*, sp. nov.—A remarkable leaf. It is a little broader than long. From its broadest obtuse part in the middle, it is broadly wedge-form to the base, and also to the top, having therefore a broadly rhomboidal form. The borders from the middle downward are entire; obtusely crenulate or undulate upward. The nerves palmately divide in five from the base, the exterior ones following the borders though not quite parallel, and ascending to middle of the leaf; the internal ones ascending in an acute angle nearly to the top, where they curve inward to the medial nerve. This one is of the same thickness, and does not branch but by veinlets. The ultimate meshes of the reticulation are broad and polygonal as in a *Populus*. The affinity of this leaf is still uncertain.

24. *Ficus? fimbriatus*, sp. nov.—This leaf, of which a fragment only is preserved, is still more remarkable than the former. Kidney-shaped in outline, truncate at its broad base, its whole upper border is surrounded by regular, erect teeth, inflated or dilated at the point as if bearing small leafy expansions, and separated by broad obtuse sinuses. The petiole is

thick, attached to the leaf a little above the lower border, which is thus continuous. It is palmately seven-nerved, the nerves scarcely branching, diverging all around and vanishing before reaching the borders. The veinlets are perpendicular to the veins, slightly arched, subcontinuous; ultimate reticulation polygonal, small, like that of a *Ficus*. But the relation with this genus is uncertain.

25. *Platanus aceroides?* Göpp., var. *latior*.—Leaf broader than long, palmately trilobate, with short scarcely distinct lateral lobes; borders distantly dentate, flat or undulate between the teeth, the short teeth like the lobes pointing outward. The primary nerves diverge from the petiole just at the border of the leaf, under an angle of 40° to 50°, like the secondary ones. The base of the leaf is slightly rounded or rather truncate, the petiole thick, the substance of the leaves pretty thick and the surface rough. It may be a distinct species, differing from the more common forms of *P. aceroides* by a comparatively broader leaf, shorter lobes, and teeth pointing outward. But we find the same characters in *Platanus rugosus* Göpp., a Miocenic species which Prof. Heer considers as a mere variety of *P. aceroides*.

26. *Platanus Newberrii* Heer.—There is only one fragment of this species among the specimens sent for examination, and it is about as broken and uncomplete as the one figured by Prof. Heer in Phyllites du Nebraska. It evidently differs from the former by its more narrowed base, the leaf descending to the petiole in a broad wedge-form. The primary and secondary nerves are proportionally narrower and the veinlets more irregular and divided. In spite of these apparent differences, the relation of both species is not positively denied. This leaf, like the former, is pretty thick, coriaceous and of large size.

27. *Platanus obtusiloba*, sp. nov.—This species, represented by many specimens, has still more numerous and marked varieties than *Platanus aceroides*. It is palmately, obscurely, irregularly trilobate, the lobes being sometimes marked merely on one side of the leaves and always more or less obtuse. The borders are rather deeply undulate than obtusely dentate, and the base either cordate or rounded or attenuated wedge-form. The size of the leaves is equally variable. The only general character recognizable on all the specimens is the position of the point of union of the primary nerves, generally in three, at a distance above the base of the leaves or the point of attach of the petiole. Except this, the nerves themselves differ in their mode of branching, the medial one especially,

which is sometimes pinnately and alternately divided and sometimes without any branches.

28. *Platanus diminutivus*, sp. nov.—Though far different in form, size, &c., from the former species, this may be still a peculiar variety of it. It is a very small leaf, no more than one inch long, nearly as broad as long, cordate, obtusely pointed in outline, with wavy borders and round base. The primary nerves are in three, but one of the lateral is lower than the other; all proportionally very thick and inflated here and there. The secondary and tertiary nervation and also the color and substance of the leaves are the same as in the former species.

29. *Credneria LeConteana*, sp. nov.—The leaf, a part of which only is preserved, is large, measuring in its broadest part about seven inches, being apparently somewhat longer. Its form is broadly subcordate, rounded at base, with borders entire. All the nerves and veinlets are deeply marked; the upper secondary nerves diverging at an angle of about 50°, while the two lower ones are shorter, narrower and nearly horizontal. It is the position of these two lower secondary pair of nerves which marks the essential character of the genus *Credneria* (Zenker), as limited by Stiehler; and this character is well distinct in our leaf whose size, outline, &c., corresponds exactly with the species described by Stiehler from the Cretaceous of the Hartz mountains. This species, like *Pterophyllum Haydenii*, points out a relation of our Nebraska Cretaceous with that of Europe.

30. *Laurus Nebrascencis* (*Persœa Nebrascencis* Lesq.), Trans. Amer. Phil. Soc., vol. xiii, p. 431, pl. 23, fig. 940.—A thick, coriaceous, ovate-lanceolate pointed leaf, narrowed downward to a pretty long and thick petiole, with the nervation of a *Laurus* or *Persœa*. From its pretty long petiole and its great likeness to *Persœa speciosa* Heer, I formerly considered this leaf as a *Persœa*. But the fruit described below, of a true *Laurus*, found in specimens from the same locality as this leaf, forces the admission of it being a *Laurus*.

31. *Laurus macrocarpus*, sp. nov.—Fruit of a *Laurus*, probably of the former species. It is a round, oval, pretty large nutlet, somewhat roughened, undulate across, and marked lengthwise by narrow, equidistant, scarcely distinguishable ribs. The support is club-shaped, smooth, marked upon its top, or on the surface where it joins the nut, by four vascular dots. The nut is inclosed into a pretty thick, apparently spongious pericarp, split around, at points corresponding to the horizontal wrinkles.

32. *Sassafras Cretaceus* Newb.—Much like our *Sassafras officinalis*, from which it would be undistinguishable, indeed, but for the thick, coriaceous substance of the leaves. The leaves taper to the base from an enlarged trilobed top; the lateral lobes, diverging and nearly horizontal, are slightly longer than the medial one, all obtusely pointed. The nervation is very distinct; the primary nerves thicker than in the living species, the reticulation exactly of the same kind.

33. *Sassafras Mudgii*, sp. nov.—Though nearly similar to the former in its general outline, it is evidently a different species. The leaf, which is nearly entire, is 8 inches long, 5 inches broad, at the point of the lateral lobes, gradually narrowing to the petiole, three lobate from the middle. Lateral lobes oblique, not half as much diverging as in the former species, proportionally narrower and more obtusely pointed. The medial lobe is twice as long as the lateral ones; substance of the leaves thinner, slightly membranaceous, polished.

34. *Sassafras subintegrifolius*, sp. nov.—The leaf appears to be trilobate or merely emarginate at its rounded top, broadly oval, tapering in an obtuse angle to the petiole, entire, subcoriaceous. It is palmately triple-nerved; the lateral nerves not being opposite but at a short distance from each other, as it is often the case in the genus *Sassafras*. This species is distantly related to *S. Æsculapi* Heer, of the Swiss Miocene.

35. *Proteoides Daphnogenoides* Heer.—Leaves ovate-lanceolate near the base, tapering upward to a very long, acute, slightly scythe-shaped point, smooth and coriaceous, attenuated downward to a short thick petiole; medial nerve narrow, secondary nerves obsolete, few, ascending under a very acute angle along the borders. These leaves are very long. Our specimens show two nearly whole leaves, one of which is 8 inches long, and only one inch broad near the base. As the species of Prof. Heer in the "Phyllites du Nebraska" are represented by mere small fragments, it is not positively certain that ours is the same.

36. *Proteoides acuta* Heer.—Leaves narrower than in the former, with a longer tapering base, undulate borders, thinner, and not polished on the surface. No trace of lateral nerve distinguishable.

37. *Lyriodendron intermedium*, sp. nov.—A part of a leaf evidently belonging to this genus. The upper segments are comparatively long, obtuse, at a distance from the lower ones, indicating a proportionally long and narrow leaf.

38. *Lyriodendron giganteum*, sp. nov.—A species represented still by a broken fragment. It is only one of the supe-

rior lobes of the leaf, with the sinus which separates the upper segments. It is broadly oval-oblong, very obtuse, thick and coriaceous, with the medial and the three secondary nerves which generally enter the upper lobes of a *Lyriodendron.* This leaf is evidently of very large size.

39. *Magnolia tenuifolia,* sp. nov.—A large leaf of thin texture, 6 inches long, 2½ inches broad, oblong, obtusely pointed?, slightly rounded and attenuated to a pretty long petiole. Secondary nerves narrow, open, angle of divergence about 60°; medial nerve sharply grooved.

40. *Magnolia alternans* Heer.—There is only one specimen recognizable of this species. It is like that of fig. 3, pl. 3, in the *Phyllites du Nebraska.* The leaf is coriaceous, ovate-oblong lancolate, gradually narrowed to the petiole; medial nerve thick, lateral veins ascending in acute angle, curving and anastomosing along the borders.

41. *Dombeyopsis obtusiloba,* sp. nov.—The finest specimen of the whole collection. The leaf is whole, merely deprived of its petiole; 7 inches long, 5 inches broad near the base where it is the broadest. Its general outline is triangular-elongated, rounded subcordate at base, gradually diminishing to an obtuse point, deeply sinuous or obtusely irregularly lobed on the borders. It is palmately seven-nerved at the base, the medial nerve thick, as well as the two proximate ones which ascend to ¾ of the leaf in an acute angle; the ultimate or basilar nerves, not quite as thick, diverge near the base of the leaf to the point of the lower lobe. The medial nerve branches from the middle; the veinlets seem to be perpendicular to the nerves but obsolete; the ultimate reticulation has pretty large, hexagonal, polygonal or square meshes, with their veinlets as distinct as those of the areas.—This leaf, for its general outline and nervation, is similar to *D. Dechenii* Web., Paleont. ii, p. 193, pl. 21, fig. 10, from the Tertiary lignitic formation of the Under Rhein., differing by proportionally greater length, obtuse lobes, round base, &c.

42. *Acer obtusilobum?* Ung.—An entire, well preserved leaf, membranaceous, triangular in outline, obtusely palmately five-lobed; basilar lobes broad and undulate, superior divisions short and obtuse.—This species might be considered as identical with that published under this name by Unger (Chloris, p. 134, pl. xliii, fig. 12 and 13), if it was not for a marked difference in the nervation. In Unger's species, the upper lateral primary nerve divide upward near the middle, and the branch ascends parallel to the medial nerve, uniting with the secondary nerves above. This kind of nervation, resembling that of a *Menispermum,* is observable in the follow-

ing species. In this leaf the nervation is craspedrome and camptodrome as in other species of *Acer*.

43. *Acerites menispermifolius*, sp. nov.—A small leaf, triangular in outline, five lobate, with short obtuse irregular lobes. Primary nerves in five from the base, the upper lateral one branching in the middle with one of the divisions ascending upward. The base of the leaf is nearly truncate. It may belong to the former species or to a true *Menispermum*. Another small leaf, also triangular, with a cuneate base, three obtuse equal short lobes, the middle one abruptly short pointed and a similar kind of nervation, may be a variety of the same species.

44. *Negundoides acutifolia*, sp. nov.—Two thin leaves, which appear to have been attached on a same common petiole, and therefore to belong to a compound leaf. The upper leaflet is smaller, ovate, lanceolate-pointed, entire; the lower one is enlarged on one side, dentate-lobed, like an *Acer*, and with the same kind of nervation, while the other side is narrow, entire, with merely secondary nerves as in the upper leaf. Prof. Unger in his Chloris has figured and described, under the name of *Acer*, two lanceolate leaves, slightly dentate, which are opposite on a common rachis, and belong, therefore, to a compound leaf resembling a *Negundo*. They have some affinity with ours.

45. *Paliurus membranaceus*, sp. nov.—Leaf exactly oval-obtuse, of a thick membranaceous substance and polished surface; palmately three-nerved from the base; lateral nerves ascending to above $\frac{2}{3}$ of the leaf, branching outward and united to the thicker medial nerve by perpendicular veinlets.

46. *Rhamnus tenax*, sp. nov.—A fine leaf represented by two fragments on the same specimen. It is lanceolate or slightly ovate-lanceolate, gradually tapering to a point and narrowed to a short petiole still attached to a branch. The secondary nerves, 14–15 pairs, ascend in an acute angle of 30°, and curve along the borders; the veinlets are obsolete, nearly continuous and perpendicular to the veins.

47. *Phyllites Rhoifolius*, sp. nov.—Two fragments of an oblong subcoriaceous thick leaf, with a broad medial nerve and secondary nerves alternate, emerging in an open angle, arched upward, curving near the borders where they unite. The borders of these leaves appear marked with distant irregular denticulations like those of our *Rhus cotinoides*, which this species resembles, also, by the nervation. The base and top of these leaves are destroyed.

48. *Juglans Debeyana* (*Populus?*) Heer.—The general form of the leaves of this species, represented by many specimens, is broad, oval and slightly obtuse; sometimes oval-lanceolate,

with a blunt point; borders always entire. Some of the leaves are equal on both sides, and have a pretty long petiole; some others are broader on one side or inequilateral, often curved to one side from a short petiole, thus showing the form of leaflets of a compound leaf. The nervation is exactly that of a *Juglans;* I consider, therefore, these leaves as belonging to this genus.

49. *Prunus Parlatorii* (*Andromeda?*) Heer.—Among the numerous specimens of this species, one of them has distinctly preserved its nervation, which is like that of a *Prunus* or of an *Amygdalus.* As the leaves are all entire, coriaceous, all lanceolate pointed, attenuated to the petiole which, like the medial nerve, is striated lengthwise, they have the essential characters of the *Prunus.* The following fruit tends to support this assertion.

50. *Prunus Cretaceus,* sp. nov.—A broadly ovate-pointed nutlet, similar in every point to a large kernel of a *Prunus,* or to a very small almond. The surface is smooth; the truncate base is notched by a groove ascending to above the middle of the nut. Another nutlet of the same kind seems to have its whole thickness imbedded in the stone showing merely its back; though it is figured, its relation is not ascertained.

51. *Phyllites Vannonœ* Heer.—The specimen does not differ from the figure and description of this species in Phyllites du Nebraska. The leaf is ovate, taper-pointed, attenuated to the base, entire, and slightly more enlarged on one side, at least near the base. Medial nerve narrow; secondary nerves obsolete.

52. *Phyllites umbonatus,* sp. nov.—A leaf perhaps deformed by compression, for the medial thick nerve is split in two from the top to the middle of the leaf, which is thus deeply cut or emarginate. The leaf about orbicular in outline is truncate at the base, irregularly lobate on the borders, with three or four pairs of secondary veins, the upper ones curved upward, those of the middle nearly at a right angle with the medial nerve, and the inferior turned downward.

53. *Phyllites amorphus,* sp. nov.—Two fragments of a coriaceous obovate entire leaf, narrowed toward the petiole; medial nerve deep and narrow; secondary nerves either horizontal, or turned downward, or ascending in an acute angle, branching also in various abnormal ways.

To complete the list of fossil plants known at this time from the Cretaceous formation of America, we have only to add to the above enumeration the plants collected by Dr. F. V. Hayden, of which a short account is given by Prof. Heer in Proceed. of Nat. Sciences of Phil., 1858, p. 265; those of Profs. Marcou

and Capellini, described and figured by Prof. Heer in "Phyllites Crétacés du Nebraska;" and those sent to me, still later, by Dr. John LeConte, which are figured and described in Appendix to Tertiary fossil plants of the Mississippi State, in Trans. Amer. Phil. Soc., vol. xiii, p. 430, pl. 23. Considering the species we find:

1. *Lyriodendron Meekii* Heer, Proc. Acad. of Nat. Sciences.—A small leaf with short round lobes not found among our specimens.
2. *Sapotacites Haydenii* Heer, loc. cit.—A leaf of unknown affinity.
3. *Laurus primigenia* Göpp. in Heer, loc. cit.—Not seen among our specimens and evidently different of *L. Nebrascensis*.
4. *Leguminosites Marcouanus* Heer, loc. cit.—Unknown to me. The author compares it to a *Cæsalpinia*.
5. *Populus leuce* Ung. in Heer, loc. cit.—Not satisfactorily recognized.
6. *Populus cyclophylla* Heer, loc. cit.—Probably the same species as the one of ours to which the specific name is preserved.
7. *Phyllites obtusilobatus* Heer, loc. cit.—An imperfect fragment, perhaps referable to *Lyriodendron Meekii*.
8. *Phyllites obcordatus* Heer, loc. cit.—Of unknown affinity.
9. *Populus litigiosa* Heer, Phyll. du Nebraska.—Fragment. Not seen in our specimens.
10. *Populus? Debeyana* Heer, loc. cit.—Described above as *Juglans Debeyana*.
11. *Salix nervillosa* Heer, loc. cit.—Not seen among our specimens.
12. *Betulites denticulata* Heer, loc. cit.—Not seen.
13. *Ficus primordialis* Heer, loc. cit.—Not seen.
14. *Platanus? Newberriana* Heer, loc. cit.—Described above.
15. *Proteoides Grevilliæformis* Heer, loc. cit.—Described above.
16. *Proteoides acuta* Heer, loc. cit.—Described above.
17. *Proteoides daphnogenoides* Heer, loc. cit., and Trans. Am. Phil. Soc., vol. xiii, pl. 23, fig. 8.
18. *Aristolochites dentata* Heer, loc. cit.—Not seen.
19. *Andromeda Parlatorii* Heer, loc. cit.—Considered in this paper as a *Prunus*.
20. *Diospyros primæva* Heer, loc. cit.—Not seen.
21. *Cissites insignis* Heer, loc. cit.—Not seen.
22. *Magnolia alternans* Heer, loc. cit.—Described above.
23. *Magnolia Capellini* Heer, loc. cit.—Not seen.
24. *Populites coriaceus* Lesq., Proc. Am. Phil. Soc., vol. xiii, p. 430, pl. xxiii.
25. *Phyllites Betulæfolius* Lesq., loc. cit.
26. *Persæa Nebrascensis* Lesq., loc. cit.—Considered as a *Laurus*.
27. *Sassafras LeConteanus* Lesq., loc. cit.
28. *Cinnamomum Heerii* Lesq., loc. cit.

Of these species, 8 are described in this paper and therefore we have to add to our number twenty, making a total of 73 species, or rather forms of leaves, from our Cretaceous.*

* It is well understood that when the word *species* is used in an examination of fossil plants, it is not taken in its precise sense. For indeed no *species* can be es-

Considering that we know scarcely anything of the Cretaceous flora of other countries, this number, though small, is indeed a valuable contribution to science. The scarcity of Cretaceous remains of plants explains perhaps the great number of species established from the Nebraska specimens. In his Phyllites, Prof. Heer remarks that between the Cretaceous plants of Nebraska and those of Europe, there are no identical species. The celebrated palæontologist sent to Dr. Debey of Aix la Chapelle, who has there discovered quite a Cretaceou flora, the drawings of the species collected by Messrs. Marcou and Capellini, inquiring about their relation to what had been discovered in Belgium. The answer was, that none of the species were identical; that even the genera were different. Of course we can not conclude from this that there is not any existing relation between the Cretaceous flora of our continent and that of Europe, because the materials which may serve as point of comparison may not have yet been discovered. Prof. Heer already finds some generic affinity between a Cretaceous flora of Moravia and ours, both containing *Magnolias* and *Ficus;* and from the remarks on the species described from Dr. Hayden's specimens, it is seen that the same generic affinity is observable with the Cretaceous flora of the Hartz mountains by one *Credneria* and one *Pterophyllum.* Nevertheless, the more we know of the floras of the geological ages of America, the more we recognize in them peculiar types which in their grouping constitute what may be called an *American facies*, which by successive transitions has passed to our present flora and assigned to it its general character. Is it not remarkable, for example, that our Cretaceous fossil plants should have a more evident relation with our present flora than with that of any stage of the Tertiary of Europe. Some of the Cretaceous species are undistinguishable from predominant species of our time. And when we consider merely the general facies of our present arborescent vegetation, we can but recognize it in the Cretaceous. *Liquidambar*, *Populus*, *Betula*, *Fagus*, *Quercus*, *Platanus*, *Credneria* (closely allied to *Coccoloba* of which we have two species in Florida), *Laurus*, *Sassafras*, *Lyriodendron*, *Magnolia*, *Acer*, *Paliurus*, *Rhamnus*, *Juglans*, *Prunus*, &c., all genera of ours and this in seventy species discovered! Is it possible to point out a more evident characteristic affinity!

From this we may at once admit, that we do not have to look for the origin of our actual vegetation to some far distant country, and to account for its nature by peculiar and cataclys-

tablished from leaves or mere fragments of leaves. But as palæontologists have to recognize these forms described and figured, to compare them and use them for references, it is necessary to affix to them specific names and therefore to consider them as *species.*

matic transportations. Its origin is not Australian as it has been sometimes admitted, nor Asiatic, still less European; but it is born, has been cradled, and has grown up on this continent. This preservation of peculiar types, present at divers geological epochs, indicates a successive and slow development of formations without such great disturbances as are recognizable in other countries; and it proves also that the climatic conditions of our North American continent have continued about the same as they are now from the Cretaceous through the Tertiary. No species found in these formations of ours indicates a warmer temperature than that of the Southern States.

We know very little yet of the vegetation of our Tertiary formations, and it is impossible to attempt now a comparison of the floras of the Tertiary and of the Cretaceous in America. Nevertheless, from the species already published, even from those of the Tertiary of Nebraska, obtained by Dr. Hayden and Dr. LeConte, the generic affinity is striking and therefore the general American facies is equally represented in both.

Vegetable remains are the records of the natural phenomena which have governed the surface of our earth at different epochs. Nowhere else can the successive development of a long series of vegetable cycles, without cataclysmatic interruptions, be followed as well as in America. When, then, the fossil plants of our country have been thoroughly studied, they will unfold to us the history of nature's proceedings during the geological times. Questions of a high order are therefore intimately allied to the study of those remains of fossil plants so little valued among us even now.

Columbus, March 19, 1868.

ART. XIII.—*Recent Eruption of Mauna Loa and Kilauea, Hawaii.*

[The following are extracts from some of the accounts of the recent great eruption on Hawaii which have reached us. The reader will be aided in understanding the geography of the island by referring to a map in volume xxvii of this Journal, p. 412, (or that in the writer's Manual of Geology, p. 696.) The district of *Kona* is on the west side of the island, between *c* and *f* nearly; that of *Kau*, on the southern, from *f* to a line running S.S.E. from Kilauea; that of *Puna*, east of Kau, and south of Hilo. *Kahuku* lies almost in a direct line between the summit of M. Loa and the south cape, 12 or 15 miles north of the cape, and this line was the course of the principal fissures

and flows of lava. The *new island* is situated just south of the south cape. *Waiohinu* is about 8 miles east of Kahuku (north of *k* on the map), 5 or 6 miles from the sea at *Kaalualu*. *Honuapo* is at *i*; *Punaluu*, 4 or 5 miles farther east on the coast. *Hiilea* lies 3 or 4 miles east of north of Punaluu. From Punuluu the road to Kilauea leaves the coast and passes through *Makaka*, *Keaiva* (about 26 m. from Kilauea), *Kapapala* (18 or 20 m. from K. and 3000 feet above the sea). Mr. F. S. Lyman lived near Keaiva. The mud-eruption of which he speaks in his letter below was a little northwest of a line between Keaiva and Kapapala; and the lava eruptions near Hiilea are west of south of the mud-eruptions; both appear to have been connected with the discharge of Kilauea, while the eruptions near Kahuku and in the line east of north from this place may have come direct from the central crater of the mountain.

The letter of Mr. Lyman to his brother, David B. Lyman of Chicago, was received by us through Prof. Lyman of New Haven. For other communications we are indebted to Prof. Alexander, of Honolulu, and the Honolulu papers.—J. D. DANA.]

1. *Letter from Rev.* TITUS COAN, (*to* J. D. DANA,) *dated Hilo, Hawaii, April* 7, 1868.

History and tradition record no such commotion on Hawaii as we have just experienced. On the 27th of March, slight and repeated shocks of earthquake were felt in Kau, the southern district of this island. On the 28th these shocks became more frequent and more energetic, extending to Hilo, Kona, and probably to all parts of the island. On this day the inhabitants of Hilo saw steam and fire shooting up from several points on the summit, and down the S. E. slope of Mauna Loa. During the same day, all Kau was startled by heavy explosions and roarings, as of a tempest, from the mountain. The mountain was rent, apparently, from near the summit crater, Mokuaweoweo, half way down its southern slope, and jets of steam and smoke went up from many points, while four distinct streams of lavas flowed out from separate fissures, and rushed down the mountain. One of these streams flowed nearly due south half way down the mountain toward Kahuku. At the same time a terrible earthquake shook down the large stone church at Kahuku, and also all the stone dwelling houses in that place, including the houses of some foreign gentlemen, who are grazing cattle at the foot of the mountain.

A letter just received from Rev. T. D. Paris, of Kealakekua, South Kona, and dated March 29th, contains some facts con-

cerning that side of the island, which I take the liberty to transcribe.

"For the last 36 hours, our house and all about us have been trembling, shaking and heaving, as if the very foundations were giving way. For ten hours there was a succession of shakes at intervals of from two to five minutes—vibrations, roaring and hissing, continuing most of the time, from one shock to another.

"Yesterday, during the heaving of the earth, four avalanches fell from the Kaanaloa precipice into the bay.

"Friday morning (27th), between 5 and 6 o'clock, we discovered the great mountain to be on fire, with immense columns and pillars of smoke; but as yet we are ignorant as to the course of the stream.

"Tuesday, April 1st. The shaking of the hill still continues. We have not undressed for sleeping since Friday night."

Thus far Mr. Paris.

On Saturday, the 28th, the lights on the mountain disappeared on all sides, from Kona to Hilo scarcely a puff of steam was seen, and all subaërial volcanic demonstrations ceased. All eyes were looking to the hills, and all were inquiring with amazement, "What has become of the eruption?"

Meanwhile the whole island trembled and shook. Day and night the throbbing and quaking were nearly continuous. No one attempted to count the sudden jars and prolonged throes, so rapid was their succession. And even during the intervals between the quakes, the ground and all objects upon it seemed to quiver like the surface of a boiling pot. The quaking was most fearful in Kau, and anxiety marked all thoughtful minds. The truth was, all the fires of the mountain and of Kilauea were sunk in subterranean caverns and chambers, and were struggling to force their way down to the ocean. The sea of lavas must have been enormous, and it was working, underground, in numerous ducts, under a tract many miles broad. The shocks and quiverings continued with different degrees of intensity until Thursday, the 2d inst.

It was now evident that Kilauea, and the mother mountain, Loa, were acting in concert. The fires in the former had become fearfully intense, shaking down avalanches of rocks from the outer walls, cracking the earth and bursting into an extinct lateral crater, called "Little Kilauea."

At 4 p. m. on the 2d instant a shock occurred, which was absolutely terrific. All over Kau and Hilo, the earth was rent in a thousand places, opening cracks and fissures from an inch to many feet in width, throwing over stone-walls, prostrating

trees, breaking down banks and precipices, demolishing nearly all stone churches and dwellings, and filling the people with consternation. This shock lasted about three minutes, and had it continued three minutes more, with such violence, few houses would have been left standing in Hilo or Kau. Fortunately there was but one stone building in Hilo, our prison, and that fell immediately.

As this awful shock died away, the sea rose some six feet above high water mark, and all the dwellings, stores, machine shops, etc., near the shore, were in imminent peril. At the same hour all Kau experienced a much more awful convulsion.

Between Kapapala and Keaiva, about twenty-six miles from Kilauea, the earth suddenly opened, among the foot hills of the mountain, a mile or two above the road leading through Kau, and a mass of earth, stones and mud was thrown up two to three miles long, and two to three miles broad, where the opening commenced, and one half to three-quarters of a mile broad, at the terminus. This earthy eruption is said to be four to fifteen feet deep, and the disgorgement was so rapid that thirty people, and 2,500 to 2,600 bullocks and horses were crushed, and all the houses of the village buried from sight. The occurrence was on a cattle ranch belonging to Reed and Richardson, and near the sheep and goat ranch of F. S. Lyman, Esq., son of Rev. D. B. Lyman, of Hilo. At the same moment, the houses of Reed and Richardson, of Mr. Lyman, and nearly all the native houses in that district, were shaken in pieces.

Simultaneously with this, there was a submarine disgorgement of lavas into the sea,* which caused a tidal wave some 15 to 20 feet high. This was fiery red, from the enormous eruption of igneous matter which broke up under the sea for miles along the shore, sweeping away every building on the lower grounds for some fifteen miles along the coast. How many lives were lost by this influx we have not yet ascertained. I have seen forty-seven names of the killed in the earthy eruption, some six miles from the sea, and this influx of the ocean. These statistics include only the eastern portion, or less than one-fourth part of Kau. We are anxiously waiting for news from the central and western portions of the district. Before the terrible shock of the 2d, we had heard that the churches and many dwellings at Waiohinu and onward to Kahuku, were in ruins; but since that event no messenger has come from all that region to report.

It is said that the great earth eruption near Kapapala was not heated, and that there was no appearance of fire in the dis-

* So Mr. Lyman thinks.

gorgements. The whole mass was thrown out of the earth like the discharge of a cannon, with a rush of wind and an awful roar. The whole action was seen by Mr. Richardson and others on the N. E., and by Mr. Lyman and others on the S. W. side of the eruption. The premises of both these gentlemen came near being swallowed up in this upheaval.

For the last twelve days, few probably of the people of Hilo and Kau have put off their clothes for sleeping. Many have camped out in the fields, and all have been anxious to secure places of comparative safety.

We still have repeated shocks, which send us out of our houses by day and night, and our house has often jarred and quivered since I have been writing these lines. But the shocks are less frequent and severe from day to day.

The sympathy between Kilauea and Mauna Loa has been distinctly marked during this eruption. Like the divisions of a grand army, all the Plutonic forces of our island have seemed to act in concert; the fires in the mountain and in Kilauea rising and falling together, and the great subterranean movements, and the rush into the sea, being simultaneous. *The fires of Kilauea have been drawn off and the crater has sunk down several hundred feet, as in the eruption of* 1840.

For four or five weeks previous to this eruption, we had heavy and continuous rains, and a vast amount of water must have gone down into the earth, filling the subterranean streams and reservoirs, and causing them to overflow. The descent of such quantities of water to the rising columns of lava, and the rapid generation of steam, may have hastened and intensified the catastrophe.

We give you the facts so far as we are able to do so, leaving the philosophical reasonings and conclusions to our scientific friends.

April 10. Last evening news came in from Waiohinu and Kahuku, that all that region was in ruins. The terrors were awful. Not an undamaged house left. 67 lives lost by the influx of the sea, and no shore village standing. The lavas have broken ground in Kau and are flowing to the sea. Our shocks still continue at intervals.

2. *Extracts from a letter from Mr.* Frederick S. Lyman, *dated Hilo, April* 10*th*, 1868, *addressed to* D. B. Lyman, Esq., *of Chicago.*

. . . . In my last letter from Kau I left off writing Tuesday evening, the 31st ult. That night from about ten till two the shaking was almost incessant; it then subsided. Wednesday morning about sunrise there was a hard shock, and

again at 5 P. M. there was a severe and protracted earthquake, with considerable swaying to and fro of the earth. Nearly all that night the shaking was very severe with frequent shocks and a rumbling sound from the south. * * * *

Soon after four o'clock P. M. on Thursday we experienced a most fearful earthquake. First the earth swayed to and fro from north to south, then from east to west, then round and round, up and down, and finally in every imaginable direction, for several minutes, everything crashing around, and the trees thrashing as if torn by a hurricane, and there was a sound as of a mighty rushing wind. It was impossible to stand; we had to sit on the ground, bracing with hands and feet to keep from being rolled over. While this agitation was at its height we saw bursting out, from the top of the bluff, about a mile and a half north of us, what we supposed to be an immense torrent of molten lava, which rushed across the plain below, apparently bursting up from the ground as it went, throwing rocks high in the air, and swallowing everything in its way;—trees, houses, cattle, horses, goats and men, all overwhelmed in an instant. This devouring current passed over a distance of about three miles in as many minutes, and then ceased. Some one called our attention to the ocean, and as soon as the severity of the earthquake had sufficiently subsided, we ran to a place where we could see the coast. All along the shore from directly below our place to Punaluu, a distance of three or four miles, the sea was boiling and foaming furiously. The waves covered the shore, and the water was red for at least the eighth of a mile from the land.

With our children and our native servants we went immediately to Nahala's hill, a short distance west of our house. From the hill-top we could overlook the country. At Hiilea, a short distance farther west, a small stream of black smoking lava was oozing from the earth; and outside of the harbor at Punaluu a long black column of lava pushed itself slowly into the ocean, and finally disappeared under the waves. We stood, expecting every moment to be swallowed up by the earth, for there were frequent earthquake shocks, the ground was opening with numerous fissures, every rock and crag that could fall had fallen, and there was a continual roar as if the molten lava was surging and rushing directly under our feet. * * *

The villages on the shore were swept away by the great wave that rushed upon the land immediately after the earthquake. The eruption of earth destroyed thirty-one lives, but the waves swallowed a greater number. * * *

Mr. Richardson returned to Kau on Monday, reaching his farm at Kapapala, Tuesday noon; but as the earthquakes were

very frequent and very severe, he remained only two or three hours. While he was camping, that night, on the great sand-plain southwest of Kilauea, the clouds were lifted from the mountain, and he saw a great river of lava pouring down its southern slope in the vicinity of Waiohinu or Kahuku, and entering the sea near Kaalualu bay. At Kilauea he could see neither fire nor smoke in the crater. Last evening (Thursday), with two other white men and several natives, he sailed on the sloop Live Yankee, bound for the coast of Kau, hoping to be able to rescue all who are still endangered by the volcano.

Since last Saturday evening, the earthquake shocks at this place (Hilo) have been infrequent and very slight, but the mountain still smokes furiously. I should have mentioned the fact that in the morning of the day after the great earthquake we could see that there had been small eruptions of earth in the margin of the forest all along the side of the mountain, from the high land above Mr. Richardson's house to the hill behind our house, a distance of four miles or more. The tract covered by the great eruption was nearly a mile wide and three miles long, forming a bank of moist, clayey soil fifteen or twenty feet high. It looks precisely like a great bank of red and brown clinkers (the *aa* of the natives). A stream of water is now running through it, and far below toward the ocean.

In the earlier letter of Mr. F. S. Lyman, (dated Kau, March 31st,) addressed to D. B. Lyman of Chicago, he writes as follows:

Since we last wrote you we still live in fear and trembling. You may have already heard that an eruption broke out on Mauna Loa, a little to the southwest of the summit, about six o'clock last Friday morning, the 27th inst., without any forewarning. The fire burst up out of the ground, throwing a spray of red lava high in the air; and then a great column of smoke rose straight up thousands of feet and arched over to the east; in a few minutes a new jet was thrown up a little southeast of the first, with its column of smoke. This was soon followed by another, and then by a fourth; and soon the red lava began running down the sides of the mountain in four streams, in a southerly and easterly direction. About seven o'clock we began to hear a roaring sound which grew louder and louder until the air seemed to tremble with the incessant roar of the volcano, but finally it subsided and ceased entirely about eight o'clock. But before that time the clouds had shut down on the mountain so that we could see nothing more then. About noon we began to feel slight earthquakes, and during the night they were very frequent, some of the time, every minute or two; though very slight, they were sufficient to prevent sleep, for

almost every jar would rattle the doors and windows. After sunrise Saturday morning (28th) the shocks began to be harder, coming often two together; they increased in violence until between one and two o'clock in the afternoon, when there occurred the hardest of all, with three shocks, which lasted about a minute; the swaying motion was so great that it was hard to stand up. The rest of the day the shocks were not very severe. Saturday morning we could see the smoke, and the flow had apparently gone about ten miles due south from the source, but during the day and part of the night it was covered with clouds.

Saturday night the shocks were very frequent and quite severe; and the house made such a noise and commotion at every shock that we all moved to our native house, or none of us would have slept any. The next morning, Sunday, the line of smoke had advanced about 15 miles since the morning previous, and seemed to be directly in the line toward Capt. Brown's house in Kahuku; but, what seems singular, no light had thus far been visible except an occasional show of it at the source. Sunday the shakes were less frequent, with some hard ones until about 2 P. M. when they nearly ceased; occasional and slight all that night, and Monday also, and Monday night; but to-day (Tuesday, the 31st), about ten A. M. there was quite a severe shaking, and at five P. M. a harder one.

3. *Extracts from a letter from* H. M. WHITNEY, *editor of the Honolulu Advertiser, dated Kealakekua, April 13th, on the eruptions near Kehuku.* (From the Advertiser.)

On ascending the ridge just west of and opposite the Mamalu Pali (precipice) of Kahuku, and which was separated from us by a valley about one-eighth of a mile wide, the whole scene opened before us in one grand panorama. The valley itself was floored over with a pavement of fresh *pahoehoe* lava (solid lava stream having a nearly smooth, though often rippled and wavy surface) from ten to twenty feet deep, which appears to have been the first thrown out, and came from a crater about ten miles up the mountain, which burst out on Tuesday morning, April 7th. This crater and stream had ceased flowing, and the lava was rapidly cooling, so that we ventured to stand on it, though at the risk of burning our boots and being choked by the sulphurous gases. On Tuesday afternoon, at 5 o'clock, a new crater, several miles lower down, and about two miles directly back of Captain Brown's residence, burst out with a heavy roar and a frightful crash. The lava stream commenced flowing rapidly down the beautiful plateau, toward and around the farm-house, and the inmates had barely time to escape with

what clothes they had on, before the houses were all surrounded and enclosed with streams of fiery *aa* lava varying from five to fifty feet in depth. Fortunately all the inmates escaped safely to Waiohinu: but how narrow the escape was, and how rapid the stream flowed, may be inferred from the fact that the path by which they escaped was covered with lava within *ten minutes* after they passed over it.

The new crater, when visited by Mr. Swain, was at least one and a half miles in extent, nearly circular, but constantly enlarging its area, by engulphing its sides. While the above gentleman was looking at it, a tract of at least five acres in extent tumbled in and was swallowed up like food for the devouring element. The enlargement is going on mainly on the lower side, toward the farm-house, and it is thought that its diameter is already about two miles. Four huge jets or fountains were continually being thrown up out of this great crater, ever varying in size and height, sometimes apparently all joining together and making one continuous spouting a mile and a half long. From the lower side of the crater a stream of liquid, rolling, boiling lava poured out and ran down the plateau, then down the side of the pali (following the track of the government road), then along the foot of the pali or precipice five miles to the sea.

This was the scene that opened before us as we ascended the ridge on Friday (10th). At the left were these four grand fountains playing with terrific fury, throwing blood-red lava and huge stones, some as large as a house, to a height varying from 500 to 1,000 feet. The grandeur of this scene, ever changing like a moving panorama, no one who has not seen it can realize.

Then there was the rapid, rolling stream, rushing and tumbling like a swollen river, down the hill, over the precipice and down the valley to the sea, surging and roaring like a cataract, with a fury perfectly indescribable. This *river of fire* varied from 200 to 800 feet in width, and when it is known that the descent was 2,000 feet in five miles, the statement that it ran at the rate of *ten to twenty-five miles an hour* will not be doubted.*

We waited till night, when the scene was a hundred fold more grand and vivid. The crimson red of the lava now doubly bright, the lurid glare of the red smoke-clouds that overhung the whole, the roaring of the rushing stream, the noise of the tumbling rocks thrown out of the crater, the flashes of electric lightning, and the sharp quick claps of thunder—altogether made the scene surpassingly grand.

* Some corrections are here introduced from Mr. Whitney's later account in the Advertiser of May 9th.—Eds.

The eruption lasted five days, it ceasing entirely in the night between the 11th and 12th.

Finding it impossible to get over to Waiohinu, either by going up the mountain or by sea, we returned to this place on Saturday, and hope to go on soon by steamer.

The number of shocks which occurred at Waiohinu from March 29th to April 10th, is estimated by Mr. Silloway to have been upward of two thousand, there having been some days between three and four hundred. The heaviest shock occurred on Thursday, April 2d, being the same that was felt so sensibly at Honolulu. This destroyed every church and nearly every dwelling in the whole district.

From 10 to 12 o'clock of that day, there had been service in the large church in Waiohinu, and it was crowded with people. Only four hours after they left the heavy shock came, the walls tumbled in, and the roof fell flat—all the work of twenty seconds. At the same instant, every man, woman and child were thrown from their feet. Horses and cattle dropped down as if dead. A man riding on horseback had his horse tumble under him so suddenly, that he found himself and horse lying flat on the ground before the thought of an earthquake entered his mind.

The earth opened all through the district, and in some places left dangerous fissures, while in others it closed up again. In one place it closed twenty feet from where it opened. These fissures make it dangerous to travel in the dark. Everywhere the roads are broken up, and it will take much money and labor to restore them to their old condition.

As the *Kona Packet* was passing the south point of the island, about three miles from the shore, a conical island, four hundred feet high, rose out of the sea, midway between the vessel and the land, emitting a column of steam and smoke. The lava river flows into the sea at this island and has extended the shore out to it one mile at least, so that it is now on the main land. The packet was so near when this island burst up, that the mud was spattered on the masts and sails of the vessel. Where the lava entered the sea, there were bluish flames emitted 10 to 20 feet high, besides steam and smoke.

The scene at the eruption was a most melancholy one to witness. There were hundreds of fine cattle grazing around the farm-houses, when the lava streams surrounded them and hemmed them in. The poor animals seemed aware of the danger, but saw no way to escape. The fiery lava drew nearer and nearer, till the heat made them restless, but they would not run. They bravely looked the foe in the face, stood firm till it reached them, then fell in the stream—a sudden cloud of smoke

followed, and not a sign remained. Thus one after another fell till over two hundred were consumed.

An incident which ought not to be omitted is the shower of ashes which preceded the eruption. During Monday night (the 6th), prior to the eruption, the ground throughout the district was covered with a coating of fine sand and light pumice stone, of a light yellowish color. Where this shower of sand and pumice stone came from is as yet unknown, but probably from some vent hole near the summit crater.

The tidal wave was much greater than before stated. It rolled in over the tops of the cocoanut trees, probably sixty feet high, and drove the floating rubbish, timber, etc., inland a distance of a quarter of a mile in some places, taking out to sea when it returned, houses, men, women, and almost everything movable. The villages Punaluu, Ninole, Kawaa and Honuapo were utterly annihilated.

4. *Letter of* Dr. Wm. Hillebrand, *on the Crater of Kilauea and the eruptions southwest*, published in the Hawaiian Gazette.

Dr. William Hillebrand visited the crater of Kilauea and the scene of the mud flow, and has published a very interesting report of his observations, from which the following extracts are taken.

The ground around the crater of Kilauea, particularly on the eastern and western sides, is rent by the great number of fissures, one near the Puna road more than twelve feet wide and very deep. Others of lesser size run parallel to and cross the Kau road so as to render travel on it very dangerous. The look-out house is detached from the mainland by a very deep crevasse, and stands now on an isolated, overhanging rock, which, at the next severe concussion, must tumble into the pit below. Many smaller fissures are hidden by grass and bushes, forming so many traps for the unwary. The Volcano House, however, has not suffered, nor is the ground surrounding it broken in the least. From the walls of Kilauea large masses of rock have been detached and thrown down. On the west and northwest side, where the fire had been most active before the great earthquake of April 2, the falling masses probably have been at once melted by the lava and carried off by its stream, for the walls there remain as perpendicular as they were before, but that this portion of the wall has lost portions of its mass, is shown too evidently by the deep crevices along the western edge just spoken of, and the partial detachment in many places of large prisms of rock. But it is on the east and northeast wall particularly, that the character of the crater has undergone a change. Along the descent on the second ledge, large

masses of rock, many more than one hundred tons in weight, obstruct the path and form abutments to the stone pillars—small buttress hills, similar to those observed in front of the high basaltic wall in Koolau, Oahu. So also in the deep crater itself, the eastern wall has lost much of its perpendicular dip, and has become shelving in part.

The crater itself was entirely devoid of liquid lava; no incandescence anywhere; pitchy darkness hovered over the abyss the first night. I say the first night, because during the second night of our stay, between twelve and one A. M., detonations were heard again, and light reappeared for a short time in the South Lake. White vapors of steam issued from the floor in a hundred places, but of those stifling, sulphurous and acid gases formerly so overpowering in the neighborhood of the lakes and ovens, only the faintest trace was perceived. The heat was nowhere so great over the bottom that we could not keep our footing for a minute or more, although in many places it would forbid the touch of the bare hand. The great South Lake is transformed into a vast pit, more than five hundred feet deep, the solid eastern wall projecting far over the hollow below, while the remaining sides are falling off with a sharp inclination, and consist of a confused mass of sharp *aa*. More than two-thirds of the old floor of Kilauea has caved in, and sunk from one hundred to three hundred feet below the level of the remaining floor. The depression embraces the whole western half, and infringes in a semicircular line on a considerable portion of the other half. It is greatest in the northern and rather gradual and gentle in its southern portion. Entering upon the depressed floor from the southern lake, it was some time before we became fully aware of its existence. It was only on our return from the northwest corner, where it is deepest, that there presented itself, through the mist in which we were enveloped, a high wall of three hundred feet of grotesque and fantastic outlines. At first we were quite bewildered, fancying that we beheld the great outer wall of the crater. On nearer approach, we soon satisfied ourselves that this singular wall represented the line of demarcation of a great depression in the floor of the crater, a fact that surprised us the more, as a bird's eye view from above had altogether failed to apprise us of its existence.

As we had been informed that the principal activity of the crater before the great earthquake had been in the northwest corner, we proceeded in that direction on leaving the south lake. Having arrived at about the middle of the depression, a considerable rise in the ground presented itself on our left—to the west. Having ascended this, we found ourselves at the

brink of a fearful chasm, which fell off on our side with a beetling wall to the depth of several hundred feet, and extended about half a mile from north to south. Very hot air rose from it. Around it, toward its northern extremity, the lava is thrown up into an indescribable confusion; pile upon pile of *aa*, gorge and ridge by turns.

The caving in of the floor seemed to be still in progression, for twice during our exploration of the crater our nerves were disturbed by a prolonged heavy rumbling and rattling noise, as from a distant platoon fire of musketry, coming from the northwest corner. * * * * *

Thus far as to what we have seen. Now allow me to relate what I learned from Kaina, who has resided near the volcano without interruption for the last five months, and whose strong nerves sustained him during the fearful catastrophe introduced by the earthquake of April 2. He and the Chinaman who keeps the house, were the only persons who remained at Kilauea. He says for two months preceding the first shock, viz: from January 20 to March 29—the crater had been unusually active, eight lakes being in constant ebullition and frequently overflowing. During all this time (the date of its first appearance could not be ascertained exactly) there was in the northwest corner a "blow-hole," from which, at regular intervals of a minute or less, with a roaring noise, large masses of vapor were thrown off, as from a steam engine. This ceased about the 17th of March. At the same time the activity of the lakes became greatly increased, and Kaina anticipated mischief. March 27 the first shock was perceived. Two days later, Mr. Fornander found the bottom of the crater overflowed with fresh lava and incandescent.

Thursday, April 2, at a few minutes past four P. M., the great earthquake occurred, which caused the ground around Kilauea to rock like a ship at sea. At that moment there commenced fearful detonations in the crater; large quantities of lava were thrown up to a great height; portions of the wall tumbled in. This extraordinary commotion, accompanied with unearthly noise and ceaseless swaying of the ground, continued from that day till Sunday night, April 5, but from the first the fire began to recede. On Thursday night it was already confined to the regular lakes; on Saturday night it only remained in the great south lake, and on Sunday night there was none at all—Pele had left Kilauea. The noises now became weaker and were separated by longer intervals. By Tuesday, April 7, quiet reigned in Kilauea. On that afternoon the lava burst out at a distance of forty miles southwest, in Kahuku.

In Kapapala we were told that fire had been seen several nights in a southeast direction, and that natives had reported flowing lava there. We rode over on the morning of April 20. At a distance of five miles from Mr. Reed's dwelling, where the Puna road turns off from the Kilauea road, heavy clouds of white vapor were seen to issue from the bush, which sparsely covered the *pahoehoe* south of the road. Half an hour's ride brought us up to the place, but we were obliged to leave our horses some distance before reaching the spot, on account of fissures. After having crossed a number of them, heading for the heaviest cloud of vapor, we at last came to a deep crevasse in the *pahoehoe* at least twenty-four feet in width, no bottom visible. It narrowed and widened out in places, but nowhere was less than eight feet wide. Its length was estimated at four hundred feet. Parallel with this great crevasse, constituting a belt about six hundred feet in width, were a number of smaller ones on each side, diminishing in size with distance from it, from six feet to a few inches. From the larger openings in the former, heavy white columns of hot steam issued, which had a decidedly alkaline smell. Smaller jets of vapor, to the number of thirty, rose from the smaller fissures. We could not discover fire in any place, but it is very probable that during dark nights the reflection of the underlying lava should be thrown up; for as the steam did not seem to contain combustible material, it is unlikely that the light seen should have been produced by it. The mean direction of all the fissures was northeast nine degrees north, southwest nine degrees south, or nearly the direction of a line connecting Kilauea with Waiohinu and Kahuku. The distance of these fissures from Kilauea is thirteen miles.

Since the earthquake of April 2 reached its greatest intensity in this district, so as even to rend in twain the framework of a mountain and hurl down on the plain a portion of its flank, it is necessary to give a short description of the country in order to insure a proper understanding of the disturbance. The locality in question is that comprised between the ranch station of Messrs. Reed & Richardson, on the east, and Mr. F. S. Lyman, on the west, a distance of five miles. The government road connecting these two places runs through a fine grassy plain, which has a very gentle fall toward the sea, its elevation being about two thousand feet. Into this plain project from the slope of Mauna Loa three parallel hills, or spurs, each about one mile in length, and from eight hundred to one thousand feet in height. They include two broad valleys between them. The upper portions of these valleys rise with a steep inclination toward a ridge which runs at right angles with

the spurs, and is covered with a dense pulu forest, which extends far up the gentle slope of the dome of Mauna Loa. In the second one of these valleys—that next to Mr. Lyman's—the so-called *mud flow* took place; but very extensive landslides, confined simply to the loose earth and conglomerate, also occurred in the other valleys.

The ground around Reed & Richardson's station is intersected by numerous small cracks and fissures, running in every direction. * * * * The magnitude of the force was such as to shake off the face of the pali, burying in a minute thirty-one human beings, many hundred head of cattle, entire flocks of goats, and ending four miles from its beginning in a mighty river of mud. Before reaching this mud flow, from Reed's house, we passed two considerable streams of muddy water, of a reddish yellow color, emitting a strong odor of clay, such as may be perceived in potteries. Both streams have their origin in the landslide of the first valley. When we passed them again, two days later, they had nearly disappeared. They evidently owed their origin to the drainage of the fallen mass. The mud flow is met with three miles from Reed's. It projects itself from the spurs of the hills two miles down on the plain; begins at once with a thickness of six feet, which, toward the middle, where it forms a small hill, rises to thirty feet, averages about three-fourths of a mile in width, and contracts toward its end. From this end a long cue of boulders bears witness to the violent action of a torrent which shot out of the mud after it was deposited, and which has since perpetuated itself in a stream of some size, quite muddy, and emitting the above mentioned pottery odor, when we saw it first, on April 20, but perfectly clear and inodorous when we passed it three days later. A little higher up, a koa grove gives still stronger evidence to the strength of the propelling force. The trees first seized are snapped off and prostrate, yet the mud in that place is only a few feet deep. The mass itself is nothing but the loose red soil of the mountain side, with a good sprinkling of round boulders, with here and there stumps of trees, ferns, happuu and amaumau and entire lehua trunks. Near the lower end, a vigorous, healthy taro plant stood erect in the mud, as if it had been planted there. From its sides protruded portions of the bodies of many cattle and goats, overwhelmed in their flight; a gain of one second in time might have saved them. The surface of the mud in this lower course was rather smooth, as if it had been forced down by the agency of water, and it was still so soft that the feet sank deep into it. After we had flanked it for some distance along the side of the hill, the mud became solid enough to bear our weight, and we walked upon it to the head of the pali. The surface gradually

became more rough; the boulders increased, and detached portions of earth and stone were scattered beyond its borders, which also flattened out gradually. The ascent soon became steep, and here, on a short spur, just in the middle of the mud, stands a native house on an island of grass and taro, flanked by two trees. A poor woman who happened to be in it at the time of the outbreak escaped the awful fate which doomed the remaining members of her family, and was removed from her perilous situation a few days after, when the crust had become solid enough to bear a man's weight.

As we went on, the mass became more rough and hard, tree trunks and boulders increased, even angular rocks appeared, until, at last, the mud ceased entirely, and gave place to a sea of huge rocks, all angular and exhibiting fresh fractures, large trunks of trees crushed between and under them, and streamlets of fresh, clear water, meandering between them. This continued for the last three hundred feet of rise, and ended in a perpendicular wall of solid rock some twenty feet high, after having climbed which, we reposed under the refreshing shade of tall fern trees, for we had entered at once the great pulu forest. Seated on the trunk of a prostrate tree, we could survey the whole field of devastation we had just traversed. Immediately at our feet the rocky framework of the pali was torn up, and its contents turned topsy-turvy in dire confusion. The rocky wall we had just climbed continued itself, until it reached the sides of the two flanking hills. A perpendicular cut in the side of the latter laid open some forty feet of red earth and conglomerate. Looking behind us, we saw that the rock we were resting on was separated from the mountain by a deep crevasse, parallel to the wall and only partly visible, as it extended under the dense trees. To our left, a clear, sparkling mountain stream leaped in a bouncing cascade over the crag, and after losing its course amid the maze of rocks, gathered itself again, flowing over the solid bed rock in a deep gorge cut in the mud. This stream had existed here before, but ere it reached half down the pali, became lost in the soil. It can easily be imagined what an amount of subsoil water must have been deposited here. Bearing this in mind, and the great depth of soil and conglomerate on this slope, as indicated by the cuts in the hill sides, there seems to be no great difficulty to explain how such enormous masses of earth, at first propelled horizontally through the air, hurled down the valley by the tremendous force which tore off the side of the mountain, should then have been seized by the propelling force of the now liberated subsoil water, and carried in a mighty stream far beyond the place where at first they were deposited.

On returning, we concluded to reach and follow the ridge of the hill flanking the stream on our left. Having arrived there, we could survey the extent of the landslides on the opposite side of the hill, which were considerable. From this place, our guide pointed out to us a human figure in the distance, moving slowly over the dreary field. It was a husband searching for the body of his wife. Our guide himself, poor fellow, mourned the loss of a wife, two little boys, and both parents. All slept their long sleep under that field of desolation. Following the crest of the hill, still covered with grass and wood, we were startled by the number of fissures and crevices intersecting it in every direction. In some places one was tempted to say, that more space was occupied by them than by the solid crust.

The direction of the solid rock wall and the *crevasse* in the forest, is northeast by north to southwest by south, nearly parallel to a line connecting Kilauea with the lava outbreak in Kahuku. The stream running from the mud-flow is likely to remain permanent, as it is a continuation of the mountain stream above, and now runs upon exposed solid bed rock.

All this destruction was the work of the great earthquake of April 2. During the five days preceding it, over one thousand shocks had been counted. On that afternoon, Mr. Harbottle, at Reed's with his men, was driving cattle across the hill toward Hilo when suddenly the earth shook violently, and a great detonation was heard behind them. Horses and cattle turned round involuntarily. The whole atmosphere before them was red and black. In a very short time this subsided—some say in one minute, others in five minutes—but a black cloud continued to hover over the scene for some time. A native, who resided less than half a mile from the scene and who had friends living on the hill, found courage enough to run to it, half an hour after the occurrence. He thrust his hand in the mud and found it cold.

From that Thursday to Sunday, the earth constantly rocked and swayed, the hills seemed to alternately approach and recede. Most people became sea-sick. Strange roaring and surging noises were heard under the ground. When the ear was applied to the earth, it would often receive a distinct impression, as if a subterranean wave struck against the earth's crust.

Another account states that Dr. Hillebrand had visited the scene of the Kahuku eruption, and had found that there was there a fissure ten to twenty feet wide, from which the lavas issued, instead of a proper crater.

5. *From the Hawaiian Gazette of April 15th, on the earthquakes of April 2d, in northern as well as other parts of Hawaii, and at the islands of Maui, Lanai, and Oahu.*

The whole island was shaken, but most violently along the western, southern and eastern flank of Mauna Loa, the damage extending from Kealakekua on the west to Hilo on the northeast. On the northern side of Hawaii, through Hamakua, Kohala and Kopa, the shocks, though frequent, were comparatively light, except the one on Thursday afternoon, but even this, though causing people to run out of their houses, did no damage to buildings. The Kohala plantation chimney and buildings were not injured. We believe that the immunity of the northern districts is owing to the mountains of Mauna Kea, Hualalai, and the Kohala Range which intervenes between them and Mauna Loa. It is believed that the Kohala Mountains are the oldest formation on the island, the volcanic fires having moved southward as successive portions of the island were thrown up.

At Kona the shock of Thursday was terrific. We are again indebted to Mr. Williamson for accurate observations of this and of the other shocks which visited that district. The vibrations are described by the residents as continuous for hours at a time, the windows and doors rattling with increasing and diminishing violence in response to the movements of the earth. A few buildings were thrown down, and the sea ebbed and flowed, leaving fish stranded on the rocks. The motion of the water was equal to about eight feet perpendicular. The people of this and the Kau district were made sick by the motion, the same as if at sea, with nausea and pains in the stomach and loss of sleep at night.

The great shock of Thursday afternoon, according to a letter from Judge Jones of Lahaina in the Hawaiian Gazette of the 8th, was felt at that place on Maui and lasted 90 seconds. It shook furniture, pictures, and walls, and the sea receded to a small extent about 5 P. M. The sea ebbed and flowed several times, the intervals between the successive flows 7 or 8 minutes. Similar shocks occurred on Lanai.

Still farther from the scene of eruption, on Oahu (150 miles from Hawaii) the earthquakes were slight. At 4 P. M. on Thursday, the first of them occurred. It was very light, and was noticed mostly by those inside of stone buildings. The majority of our people were not aware that a tremble had occurred. The motion was lateral and quick. The sea, as at Lahaina, was observed to recede and flow, but the disturbance was not great.

On Friday night we were visited again at 12:30, with another severe shock. The vibration was very perceptible, windows

and doors rattled, and many were awaked from their sleep. Another lateral shock occurred about 1 o'clock A. M., and two others before 3 o'clock.

The same shocks were noticed at Kaneohe, and one planter rushed out to look after his sugar house chimney; no harm came to it. Probably these shocks of Friday night extended over all of this Island.

[The fact that northern Hawaii was much less shaken by earthquakes than southern, the island Maui just northwest of Hawaii, feebly so, and Oahu only 150 miles distant, much more feebly, indicates that the source of the disturbance was situated directly beneath Mauna Loa, and not far (if at all) below the level of the part of the ocean's bottom lying within the Hawaiian seas, and that therefore it was eminently a local phenomenon.

The submarine rocks of the island, everywhere cavernous or somewhat loosely put together as common with volcanic accumulations, must have all cavities filled with water from the suberincumbent ocean. Mauna Loa, although nearly 14,000 feet high, and 3000 square miles in area, has only one or two surface streams over more than three-fourths of this area. As the writer observes in his Geological Report on the Sandwich Islands, the larger part of the moisture that falls annually upon the cavernous lavas becomes subterranean. Owing to the numerous vertical fractures and dikes that intersect the mountain to its base (each eruption in its history having been connected with one or more deep rendings of its sides), a portion of these waters may descend vertically to great depths, while the rest follows subterranean slopes, to emerge along the shores or beneath the ocean. (Submarine outlets of fresh water streams are common about all the volcanic islands of the Pacific.) It is to be noted further that the subterranean water-courses may have in some cases considerable size from under-ground erosion.

These facts appear to afford an explanation of the recent volcanic operations. As Rev. Mr. Coan observes, the abundance of rain during the preceding months may have been a predisposing cause. The vertical channels of the mountains, filled to the brim from the rains, would have brought immense hydrostatic pressure upon the deep-seated water-chambers below. The water may thus have been forced deeply into the hot rocks ; and there suddenly converted into steam, it caused new fissures, with attendant earthquakes, and opened passages to hotter fires; thence came vaster rendings of the mountain and severer shocks, and, as a natural sequence, all that subsequently took place. J. D. D.]

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a new mode of forming the organic sulphacids.*—Sulphacetic, isethionic, methionic, and other organic sulphacids give off sulphurous acid when heated with potash, and may therefore be regarded as derived from neutral sulphites by the substitution of half the metal by an alcoholic or acid radical. STRECKER has succeeded in effecting this substitution directly in a number of cases. Thus iodid of methyl heated to 150° C. with a solution of sulphite of sodium yields methyl-sulphite of sodium:

$$\mathrm{CH_3I + Na_2SO_3 = CH_3SO_3Na + NaI.}$$

Under the same circumstances, bromid of ethylene and sulphite of potassium yield disulphethylenate and bromid of potassium:

$$\mathrm{C_2H_4Br_2 + 2K_2SO_3 = C_2H_4(SO_3K)_2 + 2KBr.}$$

Trichlorhydrin and sulphite of potassium yield chlorid of potassium and the potassium salt of a new acid, which the author calls trisulphoglyceric acid.

$$\mathrm{C_3H_5Cl_3 + 3K_2SO_3 = C_3H_5(SO_3K) + 3KCl.}$$

The chlorinated acids behave in a similar manner; thus monochloracetic acid by boiling with an alkaline sulphite, yields an alkaline chlorid and sulphacetate:

$$\mathrm{CH_2ClCO_2K + K_2SO_3 = CH_2\left\{\begin{matrix}CO_2K\\SO_3K\end{matrix}\right. + KCl.}$$

Under the same conditions the chlorhydrate of oxyd of ethylene yields ethionic acid:

$$\begin{matrix}\mathrm{CH_2OH}\\\mathrm{CH_2Cl}\end{matrix} + \mathrm{K_2SO_3} = \begin{matrix}\mathrm{CH_2OH}\\\mathrm{CH_2KSO_3}\end{matrix} + \mathrm{KCl.}$$

In these reactions either the whole or a part of the chlorine united directly to the carbon is replaced by $\mathrm{RSO_3}$. By heating chloroform with sulphite of potassium, the author obtained the potassium salt of sulphodichloro-methylic acid:

$$\mathrm{CHCl_3 + K_2SO_3 = CHCl_2.SO_3K + KCl}$$

The preceding reactions show clearly that the sulphacids contain the residue ($\mathrm{SO_3K}$) directly united with the carbon by the sulphur. It is probable that the ethyl-sulphurous acids isomeric with the preceding contain the same group, but united to the carbon by means of oxygen.—*Comptes Rendus*, lxvi, 537. W. G.

2. *On the transformation of uric acid into glycocoll.*—STRECKER has found that when uric acid is heated in a sealed tube to 160°–170° C. with a concentrated solution of chlorhydric or iodhydric acids, it is transformed into glycocoll, carbonic acid and ammonia:

$$\mathrm{C_5H_4N_4O_3 + 5H_2O = C_2H_5NO_2 + 3CO_2 + 3NH_3.}$$

The author remarks that if hippuric acid be considered as benzoic acid conjugated with glycocoll, we may in like manner consider uric

acid as a combination of glycocoll and cyanuric acid. The two acids characterizing the urinary secretions of the herbivores and the carnivores present relations which are closer than has been hitherto supposed.—*Comptes Rendus*, lxvi, 539. W. G.

3. *On an oxychlorid of silicon.*—By passing the vapor of chlorid of silicon through a porcelain tube either empty or filled with fragments of feldspar heated to a very high temperature, Friedel and Ladenberg have obtained an oxychlorid of silicon as a limpid liquid boiling at 136°–139° C. and having the formula $Si_2\Theta Cl_6$. By the action of this liquid upon absolute alcohol the hexethylic disilicate, $Si_2\Theta(\epsilon_2H_5\Theta)_6$, described by Friedel and Crafts, is obtained; the analogy between this liquid and the oxychlorid is shown by the formulas,

$$\Theta\begin{cases}Si(\epsilon_2H_5\Theta)_3\\Si(\epsilon_2H_5\Theta)_3\end{cases}\qquad\Theta\begin{cases}SiCl_3\\SiCl_3\end{cases}$$

The oxyd of silicon-triethyl, $\Theta\begin{cases}Si(\epsilon_2H_5)_3\\Si(\epsilon_2H_5)_3\end{cases}$, is another body in which two atoms of silicon are united by one of oxygen. As the oxyd of silicon-triethyl may be formed by heating the oxychlorid with zinc-ethyl, no reasonable doubt can be entertained as to the true constitution of the oxychlorid. The authors call attention to the analogy between the oxychlorid of silicon and perchlorinated oxyd of methyl,

$$\Theta\begin{cases}SiCl_3\\SiCl_3\end{cases}\qquad\Theta\begin{cases}\epsilon Cl_3\\\epsilon Cl_3\end{cases}$$

and suggest that the former might be called perchlorinated silicomethylic ether or oxyd of trichlorosilicon.—*Comptes Rendus*, lxvi, 539. W. G.

4. *On a universal method of reducing and saturating organic bodies with hydrogen.*—Berthelot has described a simple process by which, as he asserts, any organic body whatever may be transformed into a hydrocarbon containing the same quantity of carbon and the maximum of hydrogen. Alcohols, fatty acids, the aromatic bodies, the ethylene series, benzol, naphthaline and anthracene, the amids and ethylic amines, cyanogen and complex nitrogenous bodies like indigotine and albumine, all take up hydrogen. Even black matters like ulmin, coal, and wood charcoal, present no exceptions to the general rule.

The reagent which Berthelot employs is iodhydric acid in aqueous solution of density 2. The organic body is heated to 275° C. in a sealed tube for ten hours with a large excess of the acid, the excess of the latter over the calculated quantity being greater in proportion as the organic substance is poor in hydrogen. The remarkable reducing power of the iodohydric acid under the circumstances depends upon the fact that the acid is resolved at 275° into iodine and hydrogen. The special results of the investigation are as follows:

Part 1st. Series of fatty substances proper.

I. Carburets of hydrogen.

(1). Ethylenic carburets. $C_{2n}H_{2n}$. These carburets are first converted into iodohydric ethers and then into hydrurets. Thus for ethylene C_4H_4 we have

$$C_4H_4+HI=C_4H_5I \text{ and } C_4H_5I+HI=C_4H_6+I_2.$$

So that the total reaction is $C_{2n}H_{2n}+2HI=C_{2n}H_{2n+2}+I_2$.

(2.) Acetylenic carburets. $C_{2n}H_{2n-2}$. These are first converted into iodohydrates and then into hydrurets. Thus for acetylene we have

$$C_4H_2+2HI=C_4H_2(2HI) \text{ and } C_4H_2(2HI)+2HI=C_4H_6+I_2.$$

(3.) Formenes (marsh gas series) $C_{2n}H_{2n+2}$. These bodies being saturated undergo no change.

II. Alcohols.

The alcohols yield first iodids and then formenes. Thus for common alcohol and glycerine we have

$$C_4H_6O_2+2HI=C_4H_6+I_2+H_2O_2$$
$$C_6H_8O_6+6HI=C_6H_8+3I_2+3H_2O_2$$

III. Ethers. IV. Aldehyds. V. Acids.

For these substances the author quotes the results obtained in a former investigation. Various iodids, chlorids and bromids gave the corresponding hydrurets. The same was the case for the aldehyds and acetones. The monobasic fatty acids are changed into hydrurets by the substitution of hydrogen for an equal amount of oxygen. Thus acetic acid $C_4H_4O_4$ becomes C_4H_6. This reaction permits us to pass from any formene $C_{2n}H_{2n+2}$ to its superior homologue $C_{2n+2}H_{2n+4}$. Thus hydruret of ethylene $C_4H_4(H_2)$ heated with chlorine gives chlorhydric ether $C_4H_4(HCl)$, which, with cyanid of potassium, gives cyanid of ethyl, $C_4H_4(C_2HN)$. This last gives with alkalies propionic acid, $C_6H_6O_4$, which again with iodhydric acid yields hydruret of propylene C_6H_8. Cyanid of ethyl, heated directly with iodhydric acid gives hydruret of propyl directly, the reaction being

$$C_4H_4(C_2HN)+3H_2=C_4H_4(C_2H_4)+NH_3.$$

The bibasic acids $C_{2n}H_{2n-2}O_8$ are also changed into hydrurets, provided that they can be heated to 275° in contact with the hydracid. Thus succinic acid yields hydruret of butylene, C_8H_{10}. As Simpson has shown that succinic acid may be prepared from ethylene through cyanid of glycol, we have a process for the methodical transformation of the carburets $C_{2n}H_{2n}$ and $C_{2n}H_{2n+2}$ into $C_{2n-4}H_{2n+6}$.

VI. Alkalies.

Methylamine and ethylamine are converted respectively into marsh gas and hydruret of ethylene:

$$C_2H_2(NH_3)+H_2=C_2H_2(H_2).$$
$$C_4H_4(NH_3)+H_2=C_4H_4(H_2)+NH_3.$$

This gives a new method of resolving the organic alkalies into ammonia and the generating hydrocarbons, and Berthelot believes that it will prove of extensive application in the study of the natural alkaloids.

Part 2d. Aromatic series.

I. Benzol.

The action of the hydracid in this case depends upon its density and the quantity employed. Benzol heated to 280° for 24 hours with 80 times its weight of a solution of iodhydric acid saturated in the cold is almost completely converted into hydrid of hexylene:

$$C_{12}H_6+4H_2=C_{12}H_{14} \text{ or } C_{12}H_6+8HI=C_{12}H_{14}+4I_2.$$

A trace of hydrid of propylene is formed at the same time:

$$C_{12}H_6+5H_2=2C_6H_8.$$

When one part of benzol is heated to 280° C. with 15–20 parts of the hydracid, this reaction is different and is represented by the equation:

$$C_{12}H_6+3HI=C_6H_8+3C_2H+I_3.$$

The chlorinated derivatives of benzol yield with the hydracid benzol, which in its turn with a large excess of the acid gives hydrid of hexylene.

Phenol in like manner reproduces benzol with a small quantity of the hydracid, and hydrid of propylene with a larger quantity.

II. Toluol series.

Toluol when heated with an excess of the hydracid is completely converted into hydrid of heptylene:

$$C_{14}H_8+4H_2=C_{14}H_{16}.$$

But the total reaction is expressed by the equation

$$C_{14}H_8+12HI=C_{14}H_{16}+2H_2+6I_2.$$

With a smaller quantity of the hydracid toluol yields carbon and hydrid of propylene;

$$C_{14}H_8+2HI=C_6H_8+4C_2+H_2+I_2.$$

Benzoic acid heated with 80 parts of a saturated solution of iodhydric acid yields a mixture of the hydrids of hexylene and heptylene. The latter is the normal product, the first being formed from the benzol produced by the spontaneous decomposition of the benzoic acid. The formation of hydrid of heptylene is represented by the equation:

$$C_{14}H_6O_4+7H_2=C_{14}H_{16}+2H_2O_2.$$

With a less quantity of hydracid benzoic acid yields benzol and toluol, of which the latter only represents the normal reaction.

Oil of bitter almonds with iodhydric acid yields toluol and water with small quantities of benzol and xylol, the formation of which the author leaves unexplained.

3. Cumol, xylol and cymol.

Cumol (from coal tar) heated with the hydracid yields hydrid of nonylene:

$$C_{18}H_{12}+4H_2=C_{18}H_{20}.$$

With a less quantity of the hydracid hydrid of propylene is formed:

$$C_{18}H_{12}+6HI=2C_6H_8+3C_2+H_2+3I_2.$$

Xylol in like manner appears to yield hydrid of acetylene $C_{16}H_{18}$.

Cymol (from coal tar) yields hydrid of decylene:

$$C_{20}H_{14}+4H_2=C_{20}H_{22}.$$

III. Azotized bodies.

1. Alkaloids.

Methylamine, &c. Treated with iodhydric acid methylamine is resolved into marsh gas and ammonia:

$$C_2H_5N+H_2=C_2H_4+NH_3.$$

Ethylamine under the same circumstances yields hydrid of ethylene and ammonia:

$$C_4H_7N+H_2=C_4H_6+NH_3.$$

Aniline yields benzol and ammonia; toluidine with an excess of hydracid yields hydrid of heptylene:

$$C_{14}H_9N+12HI=C_{14}H_{16}+NH_3+H_2+6I_2.$$

Methyl-aniline yields ammonia, formene and hydrid of hexylene:

$$C_2H_2(C_{12}H_7N)+6H_2=C_2H_4+C_{12}H_{14}+NH_3.$$

Ethyl-aniline yields ammonia, hydrid of ethylene and hydrid of hexylene. Amyl-aniline yields the hydrids of amylene and hexylene and ammonia.

2. Amids.

Acetamid heated with iodhydric acid yields hydrid of ethylene, ammonia and water:

$$C_4H_5NO_2+3H_2=C_4H_6+NH_3+H_2O_2.$$

Propionitril, C_6H_5N, yields hydrid of propylene and ammonia:

$$C_6H_5N+3H_2=C_6H_8+NH_3.$$

3. Cyanogen compounds.

Cyanogen heated with iodhydric acid yields hydrid of ethylene and ammonia:

$$C_4N_2+6H_2=C_4H_6+2NH_3.$$

This reaction enables us to effect the complete synthesis of hydrid of ethylene from the elements. When cyanid of potassium and iodhydric acid are heated together, a gas is obtained consisting of equal volumes of carbonic oxyd and hydrogen. In this case there are two reactions, represented by the equations:

$$C_2HN+2H_2O_2=C_2H_2O_4=NH_3;$$
$$C_2H_2O_4=C_2O_2+H_2O_2.$$

When gaseous iodhydric acid is heated with cyanid of mercury, the reaction is expressed by the equation:

$$C_2HN+3H_2=C_2H_4+NH_3.$$

This reaction gives a new synthesis of marsh gas.

IV. Complex nitrogenized bodies.

To show the extent of the applications of the new method, Berthelot has studied the action of iodhydric acid upon indigotine and albumine. Crystallized indigotine yields ammonia and a mixture of the hydrids of octylene and heptylene. The author regards the former as normal, the reaction being:

$$C_{16}H_5NO_2+9H_2=C_{16}H_{18}+NH_3+H_2O_2.$$

The hydrid of heptylene results from a decomposition expressed by the equation:

$$C_{16}H_5NO_2+10H_2=C_{14}H_{16}+C_2H_4+NH_3+H_2O_2.$$

Albumine heated with 80 times its weight of the hydracid solution yields ammonia, liquid hydrocarbons of the formene series, a little sulphydric acid and a very large volume of hydrogen. The hydrocarbons begin to boil at 70° C. and rise to a very high temperature. The author has not examined them in detail.—*Bull. mensuel de la Société Chimique de Paris, Jan., Fév., Mars*, 1868.

W. G.

5. *Carbonylic Sulphid.*—Berthelot has repeated the experiments of Than upon carbonylic sulphid, an abstract of which appeared in the March number of this Journal, and says "je suis heureux d'en confirmer la parfaite exactitude." He gives in addition, some new and important observations of his own. He finds that potassic hydrate in aqueous solution absorbs carbonylic sulphid gas with a rapidity notably greater than it absorbs the vapor of carbonic disulphid, mixed with air or any other inert gas; although in both cases the absorption proceeds quite slowly.

Liquid bromine and concentrated sulphuric acid act similarly upon both sulphids. Potassic hydrate, moistened with alcohol, absorbs both very rapidly. Absolute alcohol and liquid hydrocarbons dissolve them both with facility. Ammonia, however, either gaseous or in solution, is the best reagent for distinguishing these two bodies from each other. While the vapor of carbonic disulphid reacts only very slowly upon liquid ammonia, carbonylic sulphid gas is absorbed immediately. The vapor of CS_2 mixed with air, may remain many hours in contact with ammonia gas, without any notable action; COS on the contrary, being mixed with dry ammonia gas, forms immediately a beautiful crystalline compound which is deposited upon the walls of the containing vessel. The formation of this body is gradual and requires some hours for completion. It results from the union of two volumes ammonia gas and one volume of carbonylic sulphid gas, thus:—

$COS+(NH_3)_2=\left.\begin{matrix}(CO)H_2N\\(NH_4)\end{matrix}\right\}S$, ammonic sulpho-carbamate. Theory foresees two remarkable reactions for this substance: 1st, one molecule of water being removed, ammonic sulphocyanate is left:—

$$\left.\begin{matrix}(CO)H_2N\\(NH_4)\end{matrix}\right\}S-H_2O=\left.\begin{matrix}(CN)\\(NH_4)\end{matrix}\right\}S.$$

2nd, if one molecule of hydric sulphid be removed, ammonic cyanate (or perhaps urea) is produced:—

$$\left.\begin{matrix}(CO)H_2N\\(NH_4)\end{matrix}\right\}S-H_2S=\left.\begin{matrix}(CN)\\(NH_4)\end{matrix}\right\}O \quad \text{or} \quad \left.\begin{matrix}(CO)H_2N\\H\\H\end{matrix}\right\}N.$$

Berthelot has succeeded in effecting both these reactions. The first is easily accomplished by heating the aqueous solution of ammonic sulpho-carbamate to 100° C., in a sealed tube. The second succeeds when an aqueous solution of the salt is maintained at a

very gentle heat, in contact with plumbic carbonate. Plumbic sulphid is rapidly formed; and the liquid, when deprived of the excess of lead by H_2S and evaporated on the water-bath, leaves a residue which, on being extracted with absolute alcohol, gives on evaporation a substance possessing all the properties of urea.—*Bull. Soc. Ch.*, II, ix, 6, Jan. 1868. G. F. B.

6. *Test for naphthalin.*—Vohl has published the following reaction, which he says furnishes an exceedingly delicate test for the presence of naphthalin. When this substance is treated with concentrated nitric acid, and the mixture diluted with considerable water, a precipitate is produced, which, after being washed, first with water and then with dilute alcohol (1 part 90 pr. ct. alcohol and 3 water), is placed in a watch-glass with a few drops of potassic hydrate and potassic sulphid, and evaporated to dryness on the water-bath. On moistening the residue with alcohol, a magnificent red-violet color is at once developed.—*J. pr. Ch.*, cii, 29, Sept. 1867. G. F. B.

7. *A Manual of Inorganic Chemistry, arranged to facilitate the Experimental Demonstration of the Facts and Principles of the Science;* by Charles W. Eliot, Professor of Analytical Chemistry and Metallurgy, and Frank H. Storer, Professor of General and Industrial Chemistry in the Massachusetts Institute of Technology. Second revised edition. New York, 1868. Ivison, Phinney, Blakeman & Co.—In a previous number of this Journal we took occasion to notice the 1st edition of this book. The good opinion then formed from an examination of a portion of the advance sheets has been confirmed and heightened by its use in the class room and laboratory during two academic terms of the Sheffield Scientific School. From no inconsiderable experience we draw the conclusion that chemistry, when taught in the recitation or lecture room merely, is very fascinating to a few and exceedingly unprofitable to the many. The reason of this is obvious. Chemistry has been and still is a science in which the disproportion between principles and facts is great beyond any parallel, and what makes the matter worse is, that the facts are for the most part without logical relations and elude the ordinary grasp of mental associations.

When the learner finds before him an enumeration of the properties of oxygen, to the effect that it is a gas, colorless, tasteless, odorless, of such a density, such refractive power, such specific heat, such radiating power, such solubility, magnetic properties, a supporter of combustion, he has a lesson that may be memorized like a list of words which govern the ablative, but he shortly comes to lose his relish for such mental aliment, especially as no academic traditions exalt this branch of drilling beyond all other means of discipline, and no venerable authority pronounces it indispensable to an education, or rewards its acquisition with a certificate of Master of Arts. We sympathize heartily with the student who fails to be satisfied with this mode of learning chemistry, and cannot look complacently on the pedagogue who stuffs his victims like a Strasbourg poulterer until their hypertrophied memories will contain no

more. There is, to be sure, no royal road to learning, but there is a least difficult and tolerable way, and this is well worth looking after, in these days, when there is so much to acquire. We have never known a class of forty young men to be not merely so satisfied with the study of chemistry, but so eager for it, as that which has lately finished a course in Eliot and Storer's Manual, spending each week two hours in the recitation room and an equal time in the laboratory. The book is not a reduction of some standard treatise executed to order for a publisher's "series," but is the work of accomplished chemists and successful teachers. As a judicious selection and presentation of facts, the book is highly satisfactory. Its crowning feature, however, is its instructions for experimenting. There have not been lacking attempts in the same direction, but here for the first time, we have a sufficient series of experiments, (363) all of which can be made by any student with a trifling outlay for apparatus and materials, and a small expenditure of time, and all of which are reasonably certain of turning successfully, and instructively, by reason of the appropriate minuteness with which the conditions of success are detailed.

As regards the development of "modern" theories, not much has been attempted and in our opinion this is well. The "modern" atomic weights are employed. The laws and consequences of combination by volume, molecular formula and quantivalence are clearly discussed from a conservative yet appreciative point of view. The authors rightly hold that a wide basis of facts and established principles must be laid as a foundation before any eminence in either practical or theoretical chemistry can be thought of. We heartily commend this book to all teachers and students of chemistry as the best we are acquainted with for really learning the elements of the science. S. W. J.

8. *On a mode of extracting the metals Molybdenum and Chromium;* by J. Eneu Loughlin, M.D. (Communicated for this Journal.)—Molybdenum was first prepared by Hjelm in the year 1782. His method consisted in heating the trioxyd of molybdenum in a porcelain crucible for 2 or 3 hours. Several other methods have since been used, prominent among them being that of heating the acid molybdate of potassium; also the reduction of molybdate of ammonium by heat, or the reduction of trioxyd of molybdenum by carbonate of soda. Molybdenum is described as a silver-white metal, not altered by contact with air at ordinary temperature. Sp. gr. 8·5; not attacked by chlorohydric acid or dilute sulphuric acid. Strong sulphuric and nitric acid on the contrary act very powerfully upon it with evolution of sulphurous acid and hyponitric acid. Having had occasion during June, 1867, to use some molybdenum, I tried the methods above stated; they were all very satisfactory as regards the yield of pure metal, but the time was rather long. I then had recourse to the reducing action of cyanid of potassium. Molybdic acid was prepared and tested according to Fresenius, page 179 and 180, Qualitative Analysis. The result being satisfactory as regarded the purity of the molyb-

dic acid, 10 grains of molybdic acid thus prepared were mixed with 15 grs. of cyanid of potassium placed in a porcelain crucible, which porcelain crucible with the lid luted was placed in another crucible, then surrounded by powdered animal charcoal and exposed to a white heat for 12 minutes. At that time the crucibles were removed, allowed to cool, and examined; the porcelain crucible was found lined with a brilliant silver-white metal of a sp. gr. 8·56, which was not attacked by chlorhydric acid, but violently attacked by nitric acid with evolution of hyponitric acid fumes; it reduced oxyd of mercury and oxyd of silver when triturated with these substances. An analysis of this showed it to consist of—

Molybdenum,	98·7
Impurities SiO_2, C,	1·3
	100·0

By the same process, using sesquioxyd of chromium in place of molybdic acid, chromium was obtained possessing a sp. gr. 6·2. The best results were procured by using a reducing mixture of cyanid of potassium and animal charcoal.

II. MINERALOGY AND GEOLOGY.

1. *A System of Mineralogy: Descriptive Mineralogy comprising the most recent discoveries;* by JAMES DWIGHT DANA, Silliman Professor of Geology and Mineralogy in Yale College, etc., aided by GEORGE JARVIS BRUSH, Professor of Mineralogy and Metallurgy in the Sheffield Scientific School of Yale College. Fifth edition, rewritten and illustrated with upward of six hundred wood cuts. xlviii and 828 pp., 8vo. New York, 1868. (John Wiley & Son, No. 2, Clinton Place. $10 in cloth.)—Mineralogy is a growing science, as is very evident from the size of the volume before us. Instead of the 530 pages of the last edition of the work, Descriptive Mineralogy here covers 825 pages, exclusive of an introductory chapter of near 40 pages. Moreover the page of the letter press is large enough nearly for a quarto (4½ inches across) exceeding in area by a fifth that of the last edition. As three-fourths of the volume is in small type and the analyses and chemical formulæ and other parts are presented with the greatest possible condensation and brevity, the covers contain material enough to make four or five ordinary octavo volumes.

The author opens his preface with several reasons for the large size of the work, alluding first to the 14 years that have elapsed since the last edition appeared, and the changes and progress of the science in that time; then to the introduction in this edition of some new features—namely, systematic and detailed descriptions of *varieties* of species; a *historical* synonymy in place of a mere list of names; chemical formulas on the *new system* of chemistry in addition to those on the old; fuller as well as completely revised blowpipe characters;—to which might be added 250 more wood cuts.

In the historical synonymy, as the preface states, "the first author

and first place of publication of a species, and of each name it has borne, and of the names of all its varieties, are stated in chronological order, with the dates of all publications cited; and besides, remarks are added in the text when the subject is one of special interest. The author further observes that "the facts and conclusions have been derived in almost all cases from the study of the original works themselves, and the treatise has thereby become to some extent, a work on ancient as well as modern mineralogy." The historical inquiries here alluded to "were prompted by a desire to place the nomenclature of mineralogy on a permanent basis; they were incident to a search after a reason for choosing one name rather than another from among the number that stand as claimants," in order thereby to escape the increasing confusion in names by applying "the methods which has proved so successful in the other natural sciences, viz: the recognition, under proper restrictions, of the law of priority."

The classification of the species is in system similar to that of the preceding edition, the progress of chemistry and the kindred species not only requiring, in the author's view, no modification of its general plan, but instead giving it new support. Yet in the minor details, the changes made are numerous and important.

The Introductory Chapter supplies such tables and simple information on chemistry and crystallography as were needed to make the volume convenient of use, even for those not familiar with these sciences. Tables of atomic weights are here included, both according to the new and old system; and also multiples of the oxygen percentages by the nine digits, to facilitate calculations. The volume is thereby complete in itself independently of the first part, which we understand will be early issued as a separate work. The introduction contains also sections on nomenclature in which the history and true principles of mineralogical nomenclature are discussed at length; a Bibliography giving a long catalogue of books consulted, and showing that the work is an authority on historical questions connected with the science; and an annotated index to the useful metals and metallic ores.

The title page, as above cited, bears the name of Prof. Brush, and the author acknowledges his important aid as follows in the preface. "In the preparation of this volume, the author owes much to the coöperation of his friend, Prof. George J. Brush. Prof. Brush has had sole charge of the blowpipe department. The pyrognostic characters have been entirely rewritten by him; and while he has had the works of Plattner and von Kobell always at hand, he has, for much the larger part of the species, made personal trials of the reactions before writing them out; so that, although the facts stated are not generally new, they still are mostly from his own observations. His skill also in analytical chemistry, and his thorough knowledge of minerals, have enabled him to remove doubts, afford aid and advice, and furnish new facts on various points throughout the progress of the work. Prof. Brush has also given the proofs, while the work was in the press, the benefit of his revision."

Speaking of the enlargement of the work and the changes it had undergone, Prof. Dana observes that "not a page and scarcely a paragraph of the preceding edition remains unaltered, and full five-sixths of the volume have been printed from *manuscript* copy;" and he adds that, "notwithstanding the impaired state of his health, this manuscript—the paragraphs on the pyrognostic characters excepted—was almost solely in his own hand writing, or in that of a copyist from it, "neither the consultation of original authorities, the drawing of conclusions, nor the putting of the results on paper, having been delegated to another."

The preface closes with the announcement (as a sequel to the statement that the work had been posted up, as far as was possible, to the date of publication) that "a series of Supplements may be looked for, from time to time, in the American Journal of Science." It is to be hoped that the publishers will have an edition of these Supplements as they are issued struck off, that they may be accessible to all who have copies of the mineralogy.

2. *The Mining and Metallurgy of Gold and Silver;* by J. ARTHUR PHILLIPS, Mining Engineer. London, E. & J. N. Spon, 48 Charing Cross, 1867. 8vo, pp. 532.—This treatise of Mr. Phillips supplies a want long felt in the literature of the mining and metallurgy of the precious metals. The author has enjoyed unusual advantages for the task he has taken in hand, and has produced a volume which contains a great amount of valuable information, and exhibits fairly the present state of knowledge, both theoretical and practical, relating to the subjects discussed. He first describes the principal gold and silver-producing districts, accompanied by such statistical information as could be obtained respecting their yield and importance; and follows this with an account of the methods employed for extracting ores, and lastly with a description of the apparatus and methods made use of for their mechanical and metallurgical treatment.

The author states "that recent observations and experience appear to lead to three important conclusions. First, that the most productive gold bearing rocks are by no means exclusively confined to the Silurian period; secondly, that aqueous agencies have been, and still are, actively at work in the formation of mineral deposits; and, thirdly, that gold ledges are not more liable than ordinary metalliferous veins to become impoverished in depth."

The account of gold mining embraces several important topics not before discussed in a competent manner in any systematic work, accessible to English readers. This is especially true of the peculiarly American system of hydraulic washing, now of cardinal importance in California and Australia, and likely to remain for generations a steady industry, proportioned in importance to the great extent of the deep-lying placers. The account of vein mining is accompanied by a full description of the best approved methods adopted in the most prosperous mines both in California, Brazil and Australia, accompanied with detailed drawings and plates. A particularly interesting account of the Morro Velho mines (commonly called San Juan d'El Rey) and of the methods of

treatment of its ores is given in the chapters on South America (Vth and Xth chapters). These mines are of special metallurgical interest as well from the peculiar character and great amount of the ore operated on, as for the methods of extracting the gold adopted, the carefulness of the management being such that the whole data needed to present a complete exhibit of all the operations of mining and metallurgy are collated and exhibited in the most precise form.*

The ore treated at *Morro Velho* mines is chiefly a mixture of magnetic, arsenical and common iron pyrites, freely disseminated in a quartzose gangue. Calcite, dolomite, brown spar, and, very rarely, copper pyrites are present in the vein. The composition of what is called "pure ore" may be taken at about 43 per cent silica, and 57 per cent pyritous matter. Of these minerals, arsenical pyrites is usually the most auriferous, although it does not occur in large quantities. Pure specimens of this substance afford, by assay, from four to six ounces of gold per ton, and wherever crystals of this mineral make their appearance the yield of the precious metal is large. Cubical pyrites is of more frequent occurrence, but is far less rich in gold, yielding at best but about an ounce and a half of gold per ton by assay. Magnetic pyrites, the most abundant sulphid, is very slightly auriferous, pure specimens yielding but about four dwt. per ton. Branches of clay slate are often found in the principal veins, and this rock, under such circumstances, commonly affords, by assay, from five to seven and a half dwt. of gold per ton. Quartz without any admixture of sulphids has never been found to be auriferous in these veins, and it is a remarkable fact, stated on the authority of Mr. Hockin, managing director of the Company, that the smallest speck of gold is rarely seen, previous to concentration, in any of the ores from this mine. In some parts the vein is cavernous, and less close in its texture than in others; but where drusy cavities are frequent, the yield of gold diminishes; the most productive matrix for gold is a compact mixture of quartz and pyrites with varying quantities of slate. The great metalliferous deposit called the Cachoeira, Bahu, and Quebra Panella, is one continuous, very irregular vein, varying in width from seven to seventy feet, and at one point reaching one hundred feet. The average thickness at the present depth 176 fathoms (1056 feet) perpendicular on the Cachoeira and 165 fathoms on the Bahu, is 19 feet; the sloping space extends over 807 square fathoms. The enclosing rock is a clay slate of tolerably uniform texture. The mineral is brought to the surface on tram ways placed on the slope of the vein, about 45°, in tubs ("kibbles") containing about a ton each. The ore is freed by hand from unproductive slate and is then reduced to fine powder by wet stamping. All the machinery is moved by water power. The pulverised ore, issuing from the stamp coffers through finely perforated copper grates, passes over bullock skins and then lower down over woolen cloths (blan-

* The last accounts which have reached us are information of the almost total destruction of these remarkable mines by a disastrous fire, rendering active operations impossible for a long time to come.

kets) placed on inclined tables. The skins are washed out in vats every hour and the blankets at longer intervals. No mercury is used in the batteries under the stamps, amalgamation being restricted to the concentrated sands from the skins, &c., which are subsequently treated in barrels.

The following table shows the quantity of rock raised and stamped, the amounts of gold produced, and annual net profits made since 1848. This company employs upward of 2,400 hands, from 120 to 130 of whom are Europeans. The number of stampheads at work, is 135 for reducing the ore in the first instance and 56 for restamping residual sand with quartz and slate; arrastres are also used for repulverising the residual sand with good effect.

Years.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.
Stone raised, tons,	67,336	67,106	79,810	82,642	85,698	86,048	87,297	89,877	86,407
Stone & ore stamped, tons,	69,004	64,313	81,629	81,236	86,866	86,433	86,848	87,424	84,323
Gold produced, lbs. Troy,	2,583	2,517	3,057	3,326	3,629	3,464	3,325	2,992	2,539
Net profits, £ stg.	38,136	35,880	51,586	55,391	49,273	44,740	34,466	23,233	787

Years.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.
Stone raised, tons,	88,901	88,968	91,361	96,612	90,896	84,758	65,435	78,883
Stone & ore stamp'd, tons,	87,270	82,880	74,528	71,902	67,508	65,697	62,147	59,607
Gold produced, lbs. Troy,	2,733	3,294	3,974	5,051	5,182	4,713	2,852	4,153
Net profit, £ stg.	8,545	38,058	60,460	96,769	87,531	63,285	*	80,438

* Loss, £14,629.

This amount of work was done by 135 stamps striking an average of 55·84 blows per minute (the stamp when new weighing with the lifters, &c., 640 lbs.), for 356·27 days per year, crushing 167·65 tons of stuff per day, or 2,683 lbs. per day per head.

The total value of the precious metals extracted to close of 1865 has been £2,902,480
The total quantity of mineral raised ..... 1,769,050 tons.
The average yield of ore ..... 4·333 oitavas per ton, or as nearly as possible, half an ounce Troy, value about 32*s.* 6*d.** The ores have on the whole been poor, but the yield tolerably uniform. If the labor had been paid for at California rates of wages the result would have been disastrous. The use of water power and cheap native labor have made the adventure extremely satisfactory. The yield for 1866 exceeded £100,000 net profit.

The details of the processes developed at these extensive mines and mills are of the greatest practical value to all persons engaged in like operations, but are out of place here. A few general results alone must suffice.

Of 1000 parts of ore stamped at Morro Velho, the relative proportions of slimes and fine sand are found to be thus:

Passing a sieve of 10,000 holes per square inch, 88 to 95 per ct.
Not passing a sieve of 2,500 holes, " " 0·28 " 0·50 per ct.

The stamping is thus seen to be extremely fine.

The auriferous material issuing from the stamping mills is associated with gold in three different states, viz:

* An oitava is 2 dwt. 7·343 grains Troy, or 8·67425 oitavas = 1 oz. Troy.

1st. Free gold capable of concentration by washing.

2nd. Free gold in a lamellar form liable to be carried off by suspension in water.

3d. Mechanically combined, gold enclosed in particles of pyrites, but capable of being liberated by further grinding.

The system of concentration adopted at Morro Velho mines, is extremely simple, cheap and economical, consisting of a series of inclined tables or boards 18 inches in width, falling about one inch in a foot, and covered with bullock skins tanned with the hair on, for about 30 feet and followed by other inclines covered by baize or blankets. These inclined sluices are called *strakes*. The following table gives many important details relating to this system as employed at Morro Velho mines:—

Name of Stamps.	No. of Heads.	No. of strakes	Length of strakes	Width of strakes.	Area of strakes, squ're ft.	Squ're ft per ton of ore stamp'd.	Tons ore passing in 24 hours.	No. of skins on strakes	No. of baizes on strakes	Quant'y of head sands pr day.
			ft. in.	ft. in.						cub. ft.
Lyon, ...	30	36	31 10	1 6	1,719	46·83	36·73	288	210	20·00
Cotesw'rth	12	13	30 6	1 4½	545	32·21	16·92	104	65	5·50
Susannah,	9	8	27 0	1 6	324	29·61	10·94	48	48	2·75
Herring,..	24	29	35 0	1 6	1,232	35·64	34·56	228	174	18·00
Powles, ..	36	42	33 7	1 3½	1,821	27·55	66·10	336	252	28·47
Addison, .	24	30	31 10	1 5	1,352	38·04	35·54	240	170	17·00
	135	158			6,993		200·79	1244	910	91·72

By this system, about 67 per cent of the gold originally present in the ore is obtained in a highly concentrated state, whilst 33 per cent which escapes is in two distinct forms: 1st, light free gold; 2d, gold enclosed in coarser particles of pyrites.

The first which has been laminated to a great extent by the action of the stamps, exposes too great an amount of surface in proportion to its weight to be saved by any known method and floats off with the slimes. Its quantity is believed to be about 10 per cent of the original amount of gold in the ore. The second is fine gold entangled in pyrites the larger part of which is saved by regrinding and by a subsequent system of *strakes*.

The system of amalgamation of the concentrated ores at Morro Velho is described in detail with careful drawings. It depends essentially on the use of revolving barrels containing 16 cubic feet, or one and a half tons of wet sand, with 60 lbs. mercury and a sufficient quantity of clean water to give the necessary degree of fluidity to enable the globlules of quicksilver formed to become properly incorporated without causing them to become sufficiently mobile to admit of the settling of the mercury and amalgam at the bottom. The barrels are then caused to revolve from 30 to 36 hours, when their contents are discharged into a washing apparatus to separate the slimes from the quicksilver and amalgam, a process which cannot be well explained without a diagram. The loss of mercury in this process on an average of the last three years has been 2·923 oz. per ton of ore stamped. The average cost of extracting the mineral from the mine and its reduction, including every expense of general management, etc., for the last ten years has been 25*s.* per

ton; out of which the cost of stamping alone has been 2*s.* 10*d.* per ton. The average value of the ores stamped is determined by assays of samples of pulp from the batteries; this last is on the authority of Mr. Attwood to the writer, and is not quoted from our author.

The account of the Australian gold mines contains much valuable information not elsewhere accessible in a compact or connected form, but our space limits our extracts to the following interesting tabular exhibit of the approximate yield, and in lbs. Troy of the principal gold-producing countries at the commencement of the present century, and for the years 1850, 1860 and 1865. The return for California and the neighboring States and territories for 1865, is probably somewhat under the truth, since it is exceedingly difficult to obtain the precise yields of Idaho, Montana, Colorado and some other outlying districts. After each absolute sum is given, its relative weight, in comparison with the grand total, produced throughout the world:—

Table showing approximate production of the principal gold fields of the world.

	1800.		1850.		1860.		1865.	
	lbs. troy.	Ratio per cent.	lbs. troy	Ratio per ct.	lbs. troy.	Ratio per ct.	lbs. troy.	Ratio per ct.
Russian Empire,	1,440	2·7	65,600	19·0	66,000	11.3	69,500	12·4
Austrian Empire, and rest of Europe,	3,500	6·5	5,600	1·6	5,500	1·0	5,500	1·0
			100	----	350	----	375	----
Southern Asia,	10,000	18·5	25,000	7·3	25,300	4·3	25,000	4·5
Africa,	600	1·2	4,000	1·1	4,000	0·7	4,000	0·7
Chilé,	7,500	13·8						
Bolivia,	1,600	3·0						
Peru,	2,400	4 4						
New Granada,	12,600	23·4 *	34,000	9·9	34,000	6·9	34,000	6·1
Brazil,	10,000	18·5						
Mexico,	4,300	8·0						
California & neighboring States and Territories,	------	-----	208,000	60·2	187,000	31·9	210,000	37·5
Rest of United St'tes,	------	-----	2,950	0·9	1,020	0·2	140	
Nova Scotia,	------	-----	------	----	------	----	2,072	0·4
British Columbia,	------	-----	------	----	20,000	3·4	11,600	2·1
Australia,	------	-----	------	----	217,500	37 0	156,000	27·9
New Zealand,	------	-----	------	----	25,000	4·3	41,400	7·4
	53,940	100	345,250	100	585,000	100	559,587	100

The portion of Mr. Phillips's book devoted to silver offers probably more matter which is new to English readers than the part we have already considered, although as regards the methods of metallurgical treatment its aim is simply to present a fair exhibition of the existing state of the arts therewith connected. The chapters devoted to the silver regions of Nevada and the new mechanical methods of treatment of ores which the experiences of the mines on the Comstock lode have evoked, will be read by all interested in such subjects, with satisfaction and instruction. We must

* The yields of these several States varies considerably from year to year, but the aggregate produce is believed to remain tolerably constant.

reserve for another notice what we have to say on this branch of the subject.

The following table offers an interesting comparison with that already quoted respecting the product of gold. It gives the approximate yield in pounds troy, of the principal silver-producing countries of the world, at the commencement of the present century, and for the years 1850 and 1865. In cases where the returns for the year indicated could not be obtained, the produce for the nearest year for which they could be obtained has been substituted. The quoted produce of the various European countries and of the United States of America may be taken in each instance as a sufficient approximation, but the figures relating to Mexico, Central America and South America, must be regarded as estimates only. A large proportion of the precious metals produced in these countries is annually exported without passing through the hands of government officers, and consequently the most reliable information that can be procured is but little to be depended on. No systematic investigations have been made in Mexico by competent persons, since the date of the writings of Duport and Chevalier.

Table showing the approximate yield of the principal silver-producing countries.

	1800.		1850.		1865.	
	lbs. troy.	Ratio per ct.	lbs. troy.	Ratio per ct.	lbs. troy.	Ratio per ct.
Russian Empire,	58,150	2·5	60,000	2·1	58,000	1·5
Scandinavia,			20,400	0·7	15,000	0·4
Great Britain,			48,500	1·7	60,500	1·5
Hartz,			31,500	1·1	28,000	0·6
Prussia,			21,200	0·7	68,000	1·7
Saxony,			63,600	2·2	80,000	2·0
Other German States,	141,000	6·0	2,500	0·1	2,500	
Austria,			87,000	3·1	92,000	2·2
France,			5,000	0·2	18,000	0·4
Italy,			-------	---	* 25,000	0·6
Spain,			125,000	4·4	110,000	2·8
Australia, New Zealand, British Columbia, Nova Scotia,	--------	----	10,000	0·4	9,500	0·2
Chili,	18,300	0·8	238,000	8·4	299,000	7·3
Bolivia,	271,300	11·6	130,000	4·6	136,000	3·3
Peru,	401,850	17·2	303,150	10·7	299,000	7·4
New Granada,	5,000	0·2	13,000	0·5	15,000	0·4
Brazil,	1,200	---	·675	---	1,500	0·4
Mexico,	1,440,500	61·7	1,650,000	58·4	1,700,000	42·3
United States,	--------	----	17,400	0·7	1,000,000	25·0
Total,	2,337,300	100	2,827,425	100	4,017,000	100

We cannot close this notice without thanking Mr. Phillips for the very able manner in which he has performed the task he has undertaken, and for bringing together in so readable and well designed a form, so much information of permanent value upon the subjects of which he treats. The book is beautifully printed and illustrated, the only regret being that these very excellencies should place it beyond the reach of a large class of readers. B. S.

* Obtained from the island of Sardinia, where it is found associated with galena.

3. *New Geological Maps and Chart.*—Prof. JAMES HALL is engaged upon a geological Map of the United States, which he informs us, will be essentially a continuation of the large map of the Canadian Survey, soon to be published. The Northern States will in fact be printed from the same plates, and the portions south and west will be continued by Prof. Hall on the same scale.

We understand also that Prof. O. C. Marsh, of Yale College, has in preparation a pocket geological map of the United States, designed for general use among students of geology. This map is intended to be a companion to Dana's Manual of Geology, and it will be issued by the same publishers.

A Geological Atlas of North America is also in course of preparation under the direction of Prof. C. H. Hitchcock, of New York. It will contain a series of maps of the different States and Territories, as well as of the British Provinces, and will soon be published in New York.

Prof. A. Winchell, of Ann Arbor, has, moreover, in progress a Geological Chart, designed to illustrate the more prominent facts of geology, which will doubtless prove of great value to teachers and students of the science.

4. *New borate from Mine Hill, Franklin, Sussex Co., New Jersey—Sussexite;* by G. J. BRUSH.—A new asbestiform borate has been found at Franklin, which I propose to describe in the next number of this Journal. The specimens were obtained at the locality by Mr. Wm. G. Mixter, of the Sheffield Laboratory.

III. BOTANY AND ZOOLOGY.

1. *The Variation of Animals and Plants under Domestication;* by CHARLES DARWIN, M.A., F.R.S., &c. American edition. 2 vols. 1868. (Orange Judd & Co., New York).—In his "Origin of Species" the author promised to give us some of the details of the changes produced in animals and plants by Man's selection, and this promise is redeemed in the work before us. The first volume is devoted to a consideration of breeds and varieties of various domestic animals and plants; the second relates to the variability of species in nature, the inheritance, crossing, hybridism, methodical selection, &c., the whole concluding with certain hypotheses and speculations.

The first volume will perhaps be most prized by naturalists, as it treats mostly of unquestioned facts concerning varieties, their characteristics, history, &c., but so arranged that they continually suggest and support the author's theory.

The second volume, it seems to us, will be most valued by practical breeders of animals and cultivators of plants, men whose professions have made them familiar with the class of facts recorded in the first. We will not at this time consider the author's well known views respecting species, and their origin, as the hypotheses and speculations referred to can hardly be discussed, or even explained, within the narrow limits of the present notice. At

present we restrict our attention to some observations recorded in the first volume.

Naturalists have generally assumed that the different breeds of domestic cattle constitute but one species; and the same of dogs, horses, sheep, &c., while practical breeders of each have as generally assumed the contrary. The author after a careful consideration of the facts, concludes that cattle, dogs and hogs are each derived from more than one wild species; but that horses, rabbits, pigeons, fowls, &c., have each descended from but one parent species. The evidences given in favor of these views are rather historical than in anything indicated by the characteristics of the breeds themselves; for there is a greater difference between extreme breeds of pigeons than those of cattle, and the difference between the different breeds of horses, is greater "than between the six or seven other living species of the genus *Equus*."

We are led to infer that he believes that sheep also have not descended from a single species. It is certain that by far the majority of successful sheep-breeders are of this opinion; and after stating the views of various authors upon this subject, some of whom believe that all the breeds are derived from a few original species, and others from many, he adds, "under such a hopeless state of doubt it would be useless for my purpose to give a detailed account of the several breeds." We regret that he did not consider the variation of some breeds within known periods. The histories of English breeds furnish ample materials. The honest and careful observer, who will record the experience of American sheep breeders within the last eighty years, will do a great service in our Natural History. The changes that have been effected step by step, in the improvement of the "Infantado" merinos in late years, the changes wrought in the Saxon and other breeds a few years ago, the effects of transplanting well marked breeds from the hills of the extreme Northern States to the plains of Texas and California, are not only subjects of immense practical importance to our industry, but also embrace a class of facts which ought not to be lost to science. Mr. Darwin treats at some length of domestic rabbits, agreeing with other naturalists, that they are all descended from the wild rabbit of Europe. We are all familiar with the remarkable difference between the breeds, some being four or five times as large as others; in color, habit and disposition, they are not less diverse. Mr. Darwin finds corresponding changes in the bony and nervous system. Paleontologists would consider the skulls of the different breeds to indicate well marked species, if they were found fossil. In the half lop-eared breeds the skull has a lateral curvature; in most breeds the capacity of the brain cavity has decreased relatively to the size of the animal or to the length of the skull. He gives a curious table of measurements illustrating this. In one breed this decrease is 23 per cent, considered relatively to the weight of the animal, and 54 per cent relatively to the length of the skull. He says, "I found on comparing the skulls of ten species of hares in the British Museum, that they differed from each other chiefly in the very same points in which domestic rabbits

vary,—namely, in general proportions, in the form and size of the supraorbital plates, in the form of the free end of the malar bone, and in the line of suture separating the occipital and frontal bones." Other parts of the skeleton show equal variation.

The varieties of domestic pigeons are described in detail; but any abstract of these chapters would be unsatisfactory. They constitute an important part of the volume, and must be read entire.

Besides mammals and birds, a few fishes and insects are considered. If the statements of bee-keepers in this country can be credited, they have attained a much greater success in breeding to points, than is here claimed for European experts.

Mr. Darwin's theories have perhaps been more kindly received by botanists than zoologists, and yet we find in the work before us, (as in his "Origin of Species.") much more space devoted to the variations of animals than of plants, in fact, but a fourth of this volume is devoted to the latter. Perhaps, like the shrewd lawyer, he elaborates his argument most where it is most wanted. Doubtless the facts relating to the geographical distribution of plants have had great weight with botanists; but it is equally true that plants vary much more than animals; whether these variations are more remarkable or not, they are certainly no less striking.

We are reasonably certain what wild species were the parents of most of our domestic animals, and also of birds. "There is in fact, only one kind of domesticated bird, namely, the Chinese goose or *Anser cygnoides*, of which the parent form is said to be still unknown or extinct." Far different is it with plants. The original wild forms of many have either become extinct, or their cultivated progeny have varied so widely that it is no longer possible to recognize their parentage. In 1855, DeCandolle gave a list of 157 of the most useful cultivated plants. Of these he believes that 85 are almost certainly known in their wild state, but on this head other competent judges entertain great doubts. Of 40 of them, he admits that the origin is doubtful, and 32 are ranked as quite unknown in their aboriginal condition. This is a large proportion. One fifth are admitted to be of unknown origin, and nearly one half doubtful. This list does not include ornamental plants, nor many useful varieties which present ill defined characters.

We cannot notice variations of plants further than of certain cucurbitaceous species, which have been so extensively investigated by Mr. Naudin, who considers *Cucurbita pepo* to be the most variable plant in the world. "The fruit of one variety exceeds in volume that of another by more than two thousand fold," and the other variations are as remarkable. Some varieties are slender vines, others erect, some with tendrils and others without. There is not an important organ that has not undergone great variations in some one or another of the varieties, and to describe all these variations would require a large volume, and yet, each of these modified forms is reasonably permanent in cultivation. Melons and cucumbers vary nearly as much. Concerning these variations, Mr. Darwin pertinently quotes Mr. Naudin's remark, that "this extraordinary production of races and varieties by a single species,

and their permanence when not interfered with by crossing, are phenomena well calculated to cause reflection."

Apropos to this family we notice an unaccountable mistake on p. 430, where, as on the corresponding page in the English edition, the water-melon is said to be *Cucurbita moschata!* This entails a misunderstanding on p. 432, where the *C. moschata* spoken of is the squash to which that name belongs, and perhaps also on the following page, where the "endless varieties of the melon" (meaning of course musk-melon, *Cucumis Melo*) are referred to. If we rightly remember, an erratum in the first English edition corrected this wrong name of *Cucurbita moschata* into *Citrullus vulgaris*, the proper name of the water-melon; but it seems to have been overlooked in the reprinting on both sides of the water.

This "authorized" American edition is from the second English edition, containing the corrections and additions in that, together with some new corrections by the author. It has a preface by the author, and an introductory note by Prof. A. Gray. It is reasonably well printed, and furnished at less than half the cost of the English edition. W. H. B.

2. *A second critical notice of Alcyonaria in the Museum of Yale College*, etc.; by A. E. Verrill.—Since the publication of the "critical remarks" in the last number, the writer has had opportunities for the reëxamination of several additional species, including some in the Collection of the Essex Institute, Salem, Mass., the Boston Society of Natural History, and the Museum of Comparative Zoology. Some of the more important points noted are here presented. *Echinogorgia* sp.; = *Antipathes flabellum* Esper (non Pallas). A species belonging to this genus, obtained by Capt. W. H. A. Putnam at Singapore, and received from the Essex Institute, is reticulated in a manner precisely similar to *Paramuricea cancellata* V., from which it can scarcely be distinguished by the axis alone, unless by its somewhat darker color. It agrees exactly with Esper's *Antipathes flabellum* (Tab. I), which is more likely to be this species than the former. Specimens of an *Echinogorgia* from Ceylon (?) referred to *E. furfuracea* (Esper sp.) approach these specimens and may be the same species. The supposed Ceylon specimens are accompanied by two other species of *Echinogorgia*. One is *E. sasappo* Köll., the other is an apparently undescribed species, with rather thick dichotomous branches and large, slightly raised verrucæ, and having large and very rough spicula.

Plexaura friabilis (Lamx.?) Verrill, Proc. Essex Inst., iv, p. 186. This species has very peculiar spicula, quite different from those of any West Indian species. They resemble most the spicula of some species of *Plexaurella*, and this species will have to be referred either to that or a new genus. Whether it be really the species described by Lamouroux is still somewhat uncertain, but to me this, rather than any West Indian form, seems most likely to be his species.

Plexaura turgida Verrill, Bulletin M. C. Z. (? Ehrenberg sp.) This proves, on microscopic examination of the spicula, to be a true *Plexaura*, and not, as previously supposed, identical with *Plexaurella crassa* Köll.

Litigorgia stenobrachis V. (Val. sp.). By some unaccountable mistake in the examination of the spicula, this species, together with *L. flexilis*, *L. rigida* V., and *L. cuspidata* V., were erroneously referred to *Eugorgia*, in the last number of this Journal.

"*Gorgonia humilis*" Verrill, Memoirs Boston Soc. Natural History, vol. i, p. 6, 1864 (non Dana). A re-examination of this species has convinced me that it is identical with *Litigorgia ramulus* from Panama. Its supposed locality (Charleston, S. C.) is probably erroneous, since a Panama species of *Astrangia* was found attached to the base of one of the specimens.

Gorgonia albicans Kölliker. The specimen from False Bay Cape of Good Hope, referred to by me in the Proceedings of the Essex Institute, vol. iv, p. 187, 1865, as a white variety of *Lophogorgia palma*, proves to be the species recently named by Dr. Kölliker. It is Esper's *Gorgonia palma, var. alba*, Tab. xl.

Note.—In the last number of this Journal, p. 417, the name of the new genus of Starfishes referred to should read *Amphiaster* instead of *Amblyaster*.

3. *Note on Ethmophyllum and Archeocyathus;* by F. B. Meek. (From a letter to J. D. Dana, dated Springfield, Illinois, June 11, 1868.)—Since preparing my remarks, published in the Journal of Science (Jan. number, p. 62, 1868) on the curious fossil from Nevada, for which I proposed the name *Ethmophyllum*, I have been led, by further comparisons, to think it probably not generically distinct from *Archeocyathus* of Billings.* At any rate, it seems to agree *very* closely in internal structure with his *A. Minganensis* and *A. profundus*. The Nevada species differ so widely in form and general appearance, as scarcely to suggest a comparison with Mr. Billings's species, and besides, I had derived my impressions of his genus entirely from his typical species, *A. Atlanticus*, which also differs so materially in internal structure, that Mr. Billings suspected it might be generically distinct from his *A. Minganensis*. If these types are generically identical, however, I can scarcely entertain a doubt but that the Nevada fossil will fall into Mr. Billings's genus, which has priority of date. In this case, the names of the Nevada species would become *Archeocyathus Whitneyi*, and *A. gracilis*.

Since examining Mr. Billings's figures of the analogous species, *A. Minganensis* and *A. profundus*, I am inclined to agree with him that these fossils belong to the *Protozoa*, and are not true corals. If so, it is possible that what appeared in sections to be a minute vesicular tissue filling the central cavity, and interseptal spaces, in the Nevada species may have been sections of minute spicula. It is also worthy of note (as may be seen by reference to my remarks in the January number of this Journal), that I was strongly impressed with the similarity of some of the internal characters of the Nevada species to some types of *Foraminifera;* while Mr. Billings states† that Prof. Dawson thought his types agreed in microscopic structure with the *Foraminifera*. If they belong to the latter group, however, the apparent spicula can scarcely be such.

* New species of Lower Silurian Fossils, p. 3, 1861.

† Palæozoic fossils, p. 356.

IV. ASTRONOMY.

1. *Theoretical Astronomy relating to the motions of the Heavenly Bodies revolving around the Sun in accordance with the law of Universal Gravitation*, &c.; by JAMES C. WATSON, 8°, pp. 662. 1868. Philad., J. B. Lippincott & Co. London, Trubner & Co.—In the first chapter of this work the author establishes briefly the equations of force and motion, and then, neglecting the perturbing forces, develops from these the various formulæ that refer to the motion of a body in a conic section, first, for its heliocentric and then for its geocentric coördinates. The equations for the corrections for aberration, parallax, precession, and nutation, are also given in full, and the whole is illustrated by a numerical example. Numerical examples also illustrate the formulæ and methods in every chapter of the volume, except the sixth and seventh.

The second chapter consists of an investigation of the differential formulæ which express the relation between the geocentric, or heliocentric places of a heavenly body, and the variation of the elements of its orbit. All the cases that are likely to occur in practice seem to be fully provided for.

The third, fourth, and fifth chapters give the formulæ for the direct computation of orbits. The third chapter is devoted to parabolic orbits, and the methods of computing them from three complete observations. As the six coördinates from three complete observations are more than sufficient to determine the five elements of a parabolic orbit, a method for correcting the elements by the variation of one of the extreme geocentric distances naturally follows in this chapter. The fourth chapter is devoted to orbits whose eccentricities are not known, and the determination of their elements from three complete observations. The fifth chapter considers the same problem where four observations are given, of which the second and third are complete, and the longitudes of the first and fourth are given, a solution required for orbits of small inclination to the ecliptic, and useful in some other cases.

The sixth chapter contains an investigation of various formulæ for the correction of the approximate elements of an orbit. These are the formulæ for computing a circular orbit from two observations, for correcting an approximate orbit by the variation of two geocentric distances, for correcting by the variation of the node and the inclination of the plane of the orbit, for correcting by the variation of one geocentric distance, the formulæ expressing relations between two places in the orbit, and those for correcting the orbit by the variation of the major axis or of two radii vectous.

The method of correcting by the variation of one geocentric distance is peculiar in that it depends upon a comparison between the differential equations of motion in an undisturbed orbit and the direction and curvature of the apparent path of the body in the heavens. It is an ingenious application of the method given by Laplace for the original computation of an orbit.

Among the formulæ for the relations of two places in the orbit those for the chord of an elliptic or hyperpolic arc in terms of the extreme radii vectores, and of the time of describing the sector, are especially worthy of attention. The methods derived therefrom for correcting elliptic orbits of great eccentricity must be useful to the computer.

The seventh chapter contains an elementary presentation of the method of least squares, and a very full explanation of the best methods and corresponding formulæ for applying it in the correction of the elements of orbits, under the various circumstances likely to occur in practice.

The final chapter of 130 pages consists of an investigation of the various formulæ for computing the special perturbations of a heavenly body, and has doubtless required more labor from the author than any other portion of the volume. Four methods are given of computing perturbations according as we consider the elements or the coördinates to vary. Special cases of comets follow, in particular that in which the comet may be regarded as moving about the common center of gravity of the sun and the disturbing planet, and that in which it comes very near to the planet. The effect of a resisting medium in space and the methods of computing it, close the chapter.

In almost all parts of the volume, but especially in the earlier portions, the author is travelling over beaten paths, yet in every chapter there are new formulæ and methods. The preparation of such a work would be impossible by one who has not been long familiar with the computation of orbits. For its original matter as well as for the elegance of its methods and formulæ it cannot fail to be for a long time a standard work in Astronomy. It is a high honor to American Astronomical Science to have produced two such works as those of Chauvenet and Watson. H. A. N.

2. *Astronomical and Meteorological Observations made at the United States Naval Observatory during the year* 1865. By the authority of the Secretary of the Navy, Rear Adm. C. H. Davis, U. S. N., Superintendent. Washington, 1867, 4to, pp. xli, 47, 29 and 550.—Together with the Astronomical observations made during the year by the several instruments, there are given the resulting right ascensions and declinations reduced to 1870, along with a general catalogue of the 2787 stars observed. The meteorological observations were made every three hours, and with them are given the mean monthly and annual results. Two very valuable appendices are included in the volume. The first is a description of the new transit circle and its adjuncts, with the methods for obtaining their errors, and the application of these methods to this instrument. The second is an investigation of the distance of the sun, and of the elements which depend upon it, by Prof. Newcomb. This consists of a discussion of about 300 observations of Mars in 1862 at places in the northern and southern hemispheres. The result is $8''{\cdot}855 \pm {\cdot}020$ for the value of the solar parallax. Combining this result with other accredited determinations of this important constant he obtains $8''{\cdot}848 \pm {\cdot}013$, corresponding to

a mean distance of 92,380,000 statute miles. From this results the value 326800±1360 for the mass of the sum, (taking the mass of the earth as unity) and 1÷(81·44±0·33) for the mass of the moon. The resulting velocity of light would be 185,600 miles per second.

3. *Small Planets.*—A small planet (95) was discovered by Dr. Luther at Bilk on the 23d of November. He has given it the name *Arethusa*. Another planet (96) was discovered by Mr. Coggia at Longchamp-Marseilles, on the 17th of Feb. On the same night Mr. Tempel, at Marseilles, added another to the list, (97), *Clotho*. He requests discoverers of the next two planets to accept for them the names *Lachesis* and *Atropos*, that the three sister Parcæ may together complete the first hundred (?) minor planets.

Upon the announcement in the Academy of Sciences at Paris by Mr. LeVerrier, of the discovery of the planet (96), exception was again taken by Mr. Delaunay to the reprehensible practice of withholding the names of the subordinates in the government observatories by whom discoveries of planets and comets are made. He added that the discoverer of planet (91), Aegina, was Mr. Borelly. The scientific world will sustain Mr. Delaunay, probably without a dissenting voice.

Prof. Watson has given to the two planets discovered by him the names, *Minerva* for (93), and *Aurora* for (94).

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Petroleum Wells in Mexico.* (From a letter addressed to Smithsonian Institute by Benj. Crowther, Esq., and communicated to this Journal by Prof. Henry.—Proceeding down the river Tuxpan in the direction of its mouth emptying into the Gulf of Mexico, and when within a mile and a half of the same, we entered the mouth of the Lagun Tampamachoco situated on the north side of Tuxpan river. From thence we steered our course generally in a north-northwest direction and landed at a point on the west bank of the Lagun, the whole distance travelled being about 20 miles from the town of Tuxpan. There is a very short water communication between this Laguna and the Rio Tampico upon which stands the city of that name.

A Mexican friend and guide landed at the point just named and proceeded to explore the best route by which to conduct us to the wells. He returned in about an hour, bringing a handfull of thick black tar, of the consistence of putty. He reported the path to be over land everywhere swampy, and advised us not to attempt to proceed, as we would be able to reach the locality only by wading bare-footed through marshes with very slippery bottom and beset with prickly and stubble undergrowth. But concluding to finish the adventure, our boots, shoes, &c., were left in the canoe, and with pants knee high we followed our guide in a northwest direction for nearly two miles. When within three-fourths of a mile of the wells, the surface of the ground was found to be covered with a continuous cracked scab of bitumen, having beneath it an ash colored soapy clay soil, upon which it was difficult to stand or walk.

Arrived at the wells, we found the principal one to cover about fifteen feet in circumference, enclosing a black and brown tarry mass and bubbling up in the center at intervals. A stick thrust into the crust of tar disappeared out of sight. About 150 yards in a northeast direction another well was found very similar in all respects; also another about 200 yards westerly from the first, and finally two others in a northeast direction, all of them bearing a general resemblance, and probably fed by the same subterranean source. Contiguous to the five openings here enumerated, two others were descried at no great distance. We concluded that not far below the surface of the ground and below the bed of the Lagun and extending into the gulf, (here about 5 miles distant) there exists a great petroleum deposit. The substance is called Chapapote by the Mexicans, and is used for paving the bottoms of canals, and painting sea-going vessels. In the Gulf of Tampico the petroleum or coal oil tar boils up in the middle of the Lagun, and large cakes of this substance in its inspissated form are floated ashore near Galveston and the coast of Texas.

2. *American Association for the Advancement of Science.*—The next meeting of the Association will be held at Chicago, during the week commencing on Wednesday, Aug. 5, 1868, at 10 o'clock A. M. A large and interesting meeting is expected. Arrangements have been made with the railroad companies, by which return tickets will be furnished free to those who attend the meeting.

Members, and those who wish to become members, are requested, on their arrival in Chicago, to register their names at the offices of the Local Committee, Parlors Nos. 3 and 4, Sherman House, where they will be furnished with all information which may be desired, in regard to accommodations, etc. J. Young Scammon is Chairman, and William Stimpson, Secretary of the Local Committee.

3. *British Association.*—The British Association holds its next meeting at Norwich, commencing Aug. 19. Joseph Dalton Hooker will preside.

OBITUARY.

Anton Rosing.—ANTON ROSING, of Christiania, was born in 1827. A sketch of his life has just been published in the *Norsk Landmandsbog* for 1868 by P. C. Asbjörnsen, well known in English literature through translations of his Norse Tales, and to American Naturalists through the citations of Mr. Marsh.

Rosing studied in Copenhagen with Oersted, and was afterward for several years chemical manager of the gas works at Christiania, and editor of the Polytechnic Journal of that city. In 1855 he was appointed by the Norwegian Government to a new chair of Agricultural Chemistry, with liberty to travel during several years. He crossed at once to Germany and studied there assiduously as well as in several Parisian laboratories.

As a scientific investigator, Rosing has done good work, and he has also written largely. Those who have known him well, however, will remember him less for these things than for the high aims he cherished, and for his remarkable power of influencing his fellow men.

Of Rosing it may be said that, though an earnest student, his great

fund of information and his proficiency in all things pertaining to chemistry seemed to be less intimately connected with laborious study than with his cordial sympathy for the labors of others, his kindliness and liberal views which endeared him to a multitude of chemists. He was a welcome guest in every laboratory, and a leading spirit wherever his lot was cast. As a speaker, he was singularly eloquent, while he showed with many of his countrymen that power over foreign tongues which sets Babel at defiance.

In Paris, a poor foreign student, supported by no patronage either of University, church or science,—his influence was felt to a remarkable degree. One of the founders of the Chemical Society of that city and its first President, to Rosing more than to any other man is doubtless to be attributed the tone and character of the earlier publications of this most distinguished Society. In that distant future when cosmopolitan journalism shall have become an accomplished fact, the *Répertoire de Chimie pure et appliquée* will be remembered as a bold, and, all things considered, a remarkably successful attempt to associate, in a purely scientific enterprise, the men of many lands. Torn by internal dissensions, of the home management in which, let it here be said, the foreign collaborators had happily no part, the *Répertoire* was merged, after five or six years, in the existing "*Bulletin*" of the Society, and the distinctive cosmopolitan character which Rosing had imparted to it was lost. As is well known, the *Bulletin* is still conducted with great ability, and takes rank as the best among chemical journals; but there are chemists not a few, and the *Rédacteur en chef* is of them, who lament the day when its now purely Gallic style and savor was tempered, if not improved, by an infusion of outer barbarism.

From Paris, Rosing passed into England and Scotland, studying chemistry and agriculture, in the interests of his chair, until stricken with palsy in 1859. He died at Christiania on the 29th of March, 1867.

Few chemists,—no matter how highly placed,—have succeeded in exerting a stronger personal influence, or in attaching to themselves so large a circle of intimate and devoted friends. Not only in the Scandinavian capitals, in St. Petersburg, and in many a German town, but in Paris, Edinburgh, Vienna, Parlermo, Milan and in more than one American city, the memory of Rosing will be cherished, and his untimely death deplored. F. S.

Prof. JULIUS PLUCKER, the physicist, of Bonn, recently died, aged sixty-seven years.

Dr. CHARLES GRAFTON PAGE, well known to all readers of this Journal as an original investigator in electro-magnetism, died in Washington, D. C., May 5, 1868, aged 56 years. A notice of his life will appear in another number of this Journal.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *A Treatise on Meteorology; with a collection of Meteorological Tables.* By ELIAS LOOMIS. 8vo, 1868. Harper and Bros., New York.—This work is intended to serve both as a text-book for instruction, and at the same time as an exposition of the most

important results of recent researches in Meteorology. The student of this science has hitherto been unable to find in a single volume its principles developed with reasonable minuteness, and at the same time a presentation of the latest investigations. The present volume adequately supplies their want. The selection and arrangement of material is judicious, and the statements are lucid.

The special student would probably prefer a more liberal reference to the names of those to whom we are indebted for recent acquisitions in this department of science. If this be a defect in a volume designed primarily as a class-book, it is in part compensated by a list of works and memoirs on Meteorology, at the end of the volume. The last chapter gives the present state of our knowledge of shooting stars, meteors, and aërolites.

At the end of the volume are thirty six tables of various kinds, useful both to the observer and to the investigator.

2. *The Butterflies of North America*, with colored drawings and descriptions; by Wm. H. Edwards. Part I, 4to, with five plates. Philadelphia: published by the American Entomological Society. April, 1868. Price $2.00 per part.—Hitherto every one who has been at all interested in this attractive group of insects must have felt the great need of reliable works with accurate colored illustrations, especially of the critical and rare species. The two principal illustrated works, hitherto published, are not only very incomplete, but rare and costly, and almost inaccessible in this country, except, perhaps in the principal city libraries.

This new work promises to fill this want in a truly admirable manner and at a price that makes it available for every one. The first number contains descriptions and beautiful illustrations of *Argynnis Diana*, *A. Cybele*, *A. Aphrodite*, *A. Nokomis*, and *A. Atlantis*. Both surfaces are represented, and, in nearly every species, both sexes. The illustrations are life size and drawn with remarkable accuracy and beauty, and the coloring is very perfect and life-like. It is proposed to continue the work by issuing a number every three months, each number containing five plates, and complete in itself. The species selected for illustration will be chiefly those not hitherto figured, or only imperfectly or erroneously represented by previous authors. The letter-press is well printed in large type, on fine paper. The work, when completed, will form an attractive volume.

3. *Observations on Polyzoa, Suborder Phylactolæmata*, with nine plates; by Alpheus Hyatt. From the Proceedings of the Essex Institute, Salem, Mass., 1866 to 1868.—In this country the very interesting group of fresh-water *Polyzoa* has hitherto attracted but little attention, even from professional naturalists. Dr. J. Leidy is the only American author who had previously written upon them.* In the present extended memoir Mr. Hyatt has described very carefully and minutely the anatomical structure of *Fredricella*, *Plumatella*, *Pectinatella*, and *Cristatella*, and has brought out with remarkable clearness, the various anatomical details by means of greatly enlarged outline figures. The various species and their varieties are also figured of natural size, showing the modes of

budding and forms of the colonies. The statoblasts or winter-buds of various species are illustrated by wood-cuts in the text, and afford valuable characters for the discrimination of the species. The last part of the work is devoted to descriptions of the genera and species observed by the author. These are three species of *Fredricella*, four of *Plumatella*, one of *Pectinatella*, and one of *Cristatella*. Of these, five are new species.

This monograph really supplies us with a nearly complete manual of all the known North American species. v.

4. *The Workshop*: A Monthly Journal devoted to the progress of the useful arts. Edited by Prof. W. BAUMER, J. SCHNORR and others. 4to, Nos. 1—4. (E. Steiger, 17 North William st., N. Y.)—This beautifully illustrated journal addresses itself especially to those engaged in the decorative arts. It furnishes carefully drawn examples of the best productions in ancient and modern art, accompanied with working plans on a larger scale to guide the artist in reproducing the designs. Original articles on style in connection with industry, and on art instruction, and reports on raw materials and new processes, accompany the descriptions of special designs. This timely journal may be considered an outgrowth of the Paris Exhibition of 1867. It is of peculiar value to the American art worker in whatever department of art industry he may be engaged, and is furnished at the moderate cost of $5.40 per annum.

5. *Transactions of the American Entomological Society, Philadelphia*, vol. i, No. 4.—This number closes the first volume of the Transactions of this Society. The memoirs of the volume are all of high merit, and the illustrations, of which there are many plates besides wood-cuts, excellent. No. 4, finishes the Geotrupes of Boreal America by G. H. Horn; and includes, after this, Descriptions of American Lepidoptera, with two colored plates, by A. R. Grote and C. T. Robinson; Notes on the Apple Bark-Louse (*Lepidosaphes conchiformis*), with a description of a supposed new Acarus, by H. Shimer; Catalogue of a small collection of Hymenoptera made in New Mexico in 1867, by E. T. Cresson; Catalogue of works in the Library of the Society.

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The Elements of Physiology and Hygiene, a Text Book for Educational Institutions; by Thos. H. Huxley, LL.D., F.R.S., and Wm. Jay Youmans, M.D., with numerous illustrations. New York, 1868. 12mo, pp. 420. (D. Appleton & Co.)

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Lessons in Elementary Chemistry: Inorganic and Organic, by Henry E. Roscoe, B.A., F.R.S., Prof. of Chemistry in Owens College, Manchester. New York, 1868. (Wm. Woods & Co., 61 Walker st.

The Magnetism of Ships and the Deviations of the Compass. A series of papers from the transactions of Foreign Societies, by Poisson Airy, Archibald Smith, Fredk. John Evans, R.N., W. W. Rundell, &c., reprinted by order of the Secretary of the Navy, under the direction of Commodore Thornton A. Perkins, U. S. N., Chief of the Bureau of Navigation. Edited, and the memoir of Poisson translated by B. Franklin Greene, C. E. 860 pp.

Production of Iron and Steel in its economic and social relations, by Abram S. Hewitt, U. S. Commissioner to the Univ. Expos. at Paris, 1867. 104 pp. 8vo. Washington, 1868.

Notes on the Geology of the Survey for the extension of the Union Pacific Railway, E. D., from the Smoky Hill river, Kansas, to the Rio Grande; by John L. LeConte, M. D. 68 pp. 8vo. Philadelphia, 1868.

Monograph of the Terrestrial Mollusca of the U. States, by Geo. W. Tryon, Jr. Over 200 pp. with 18 lithogr. plates crowded with figures. A few copies on sale by the Conchological section of the Acad. Nat. Sci. Philadelphia; pr. uncolored $8,50; colored, $13.50; with duplicate plates, colored and tinted, printed on plate paper, $20.00. Address E. J. Nolan, M. D., Treas. of Publication Committee.

Report on the Bahamas' Hurricane of Oct., 1866, with a description of the city of Nassau; by Gov. Rawson, C. B. Nassau, (E. C. Moseley.)

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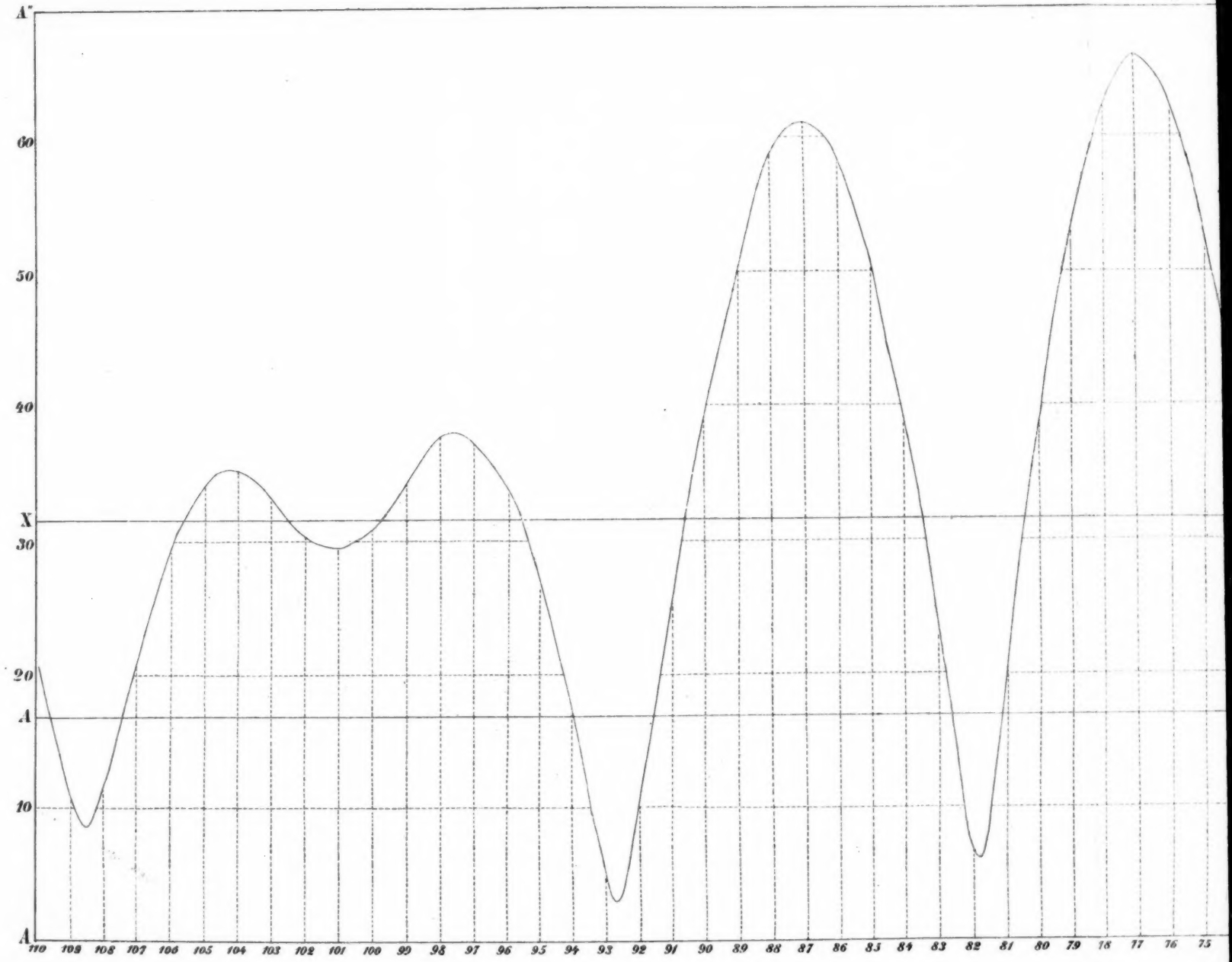
Curve showing



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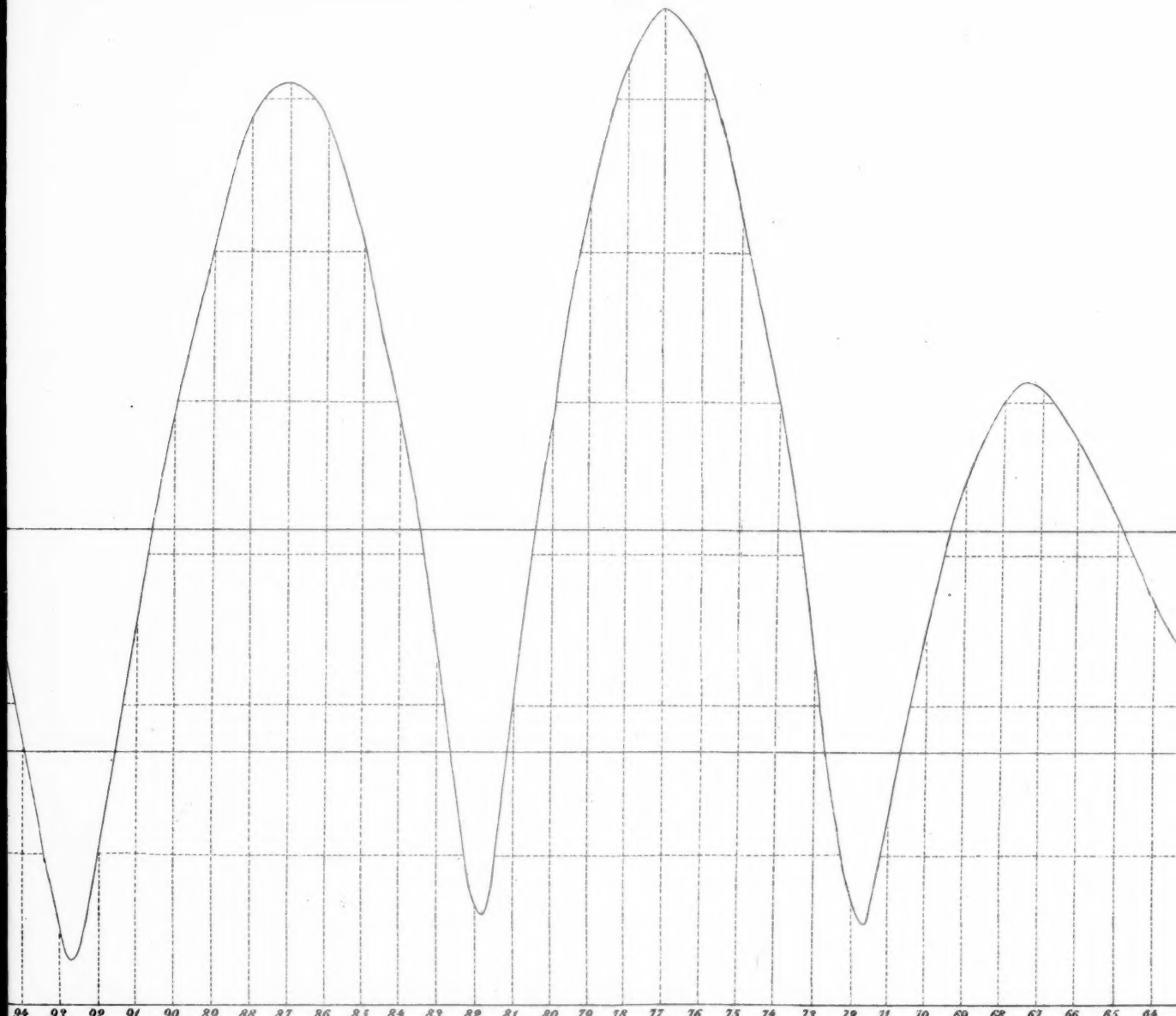

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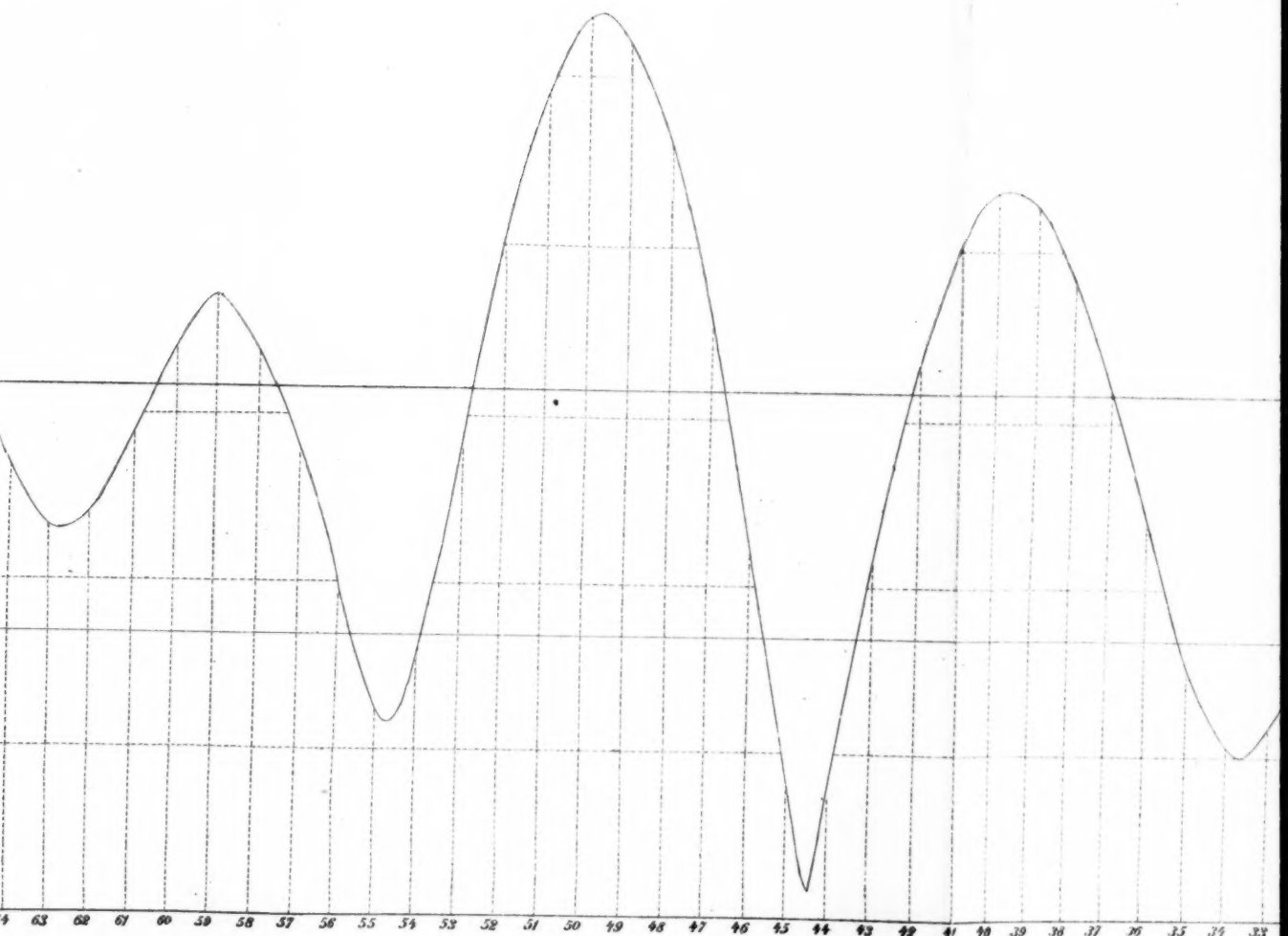

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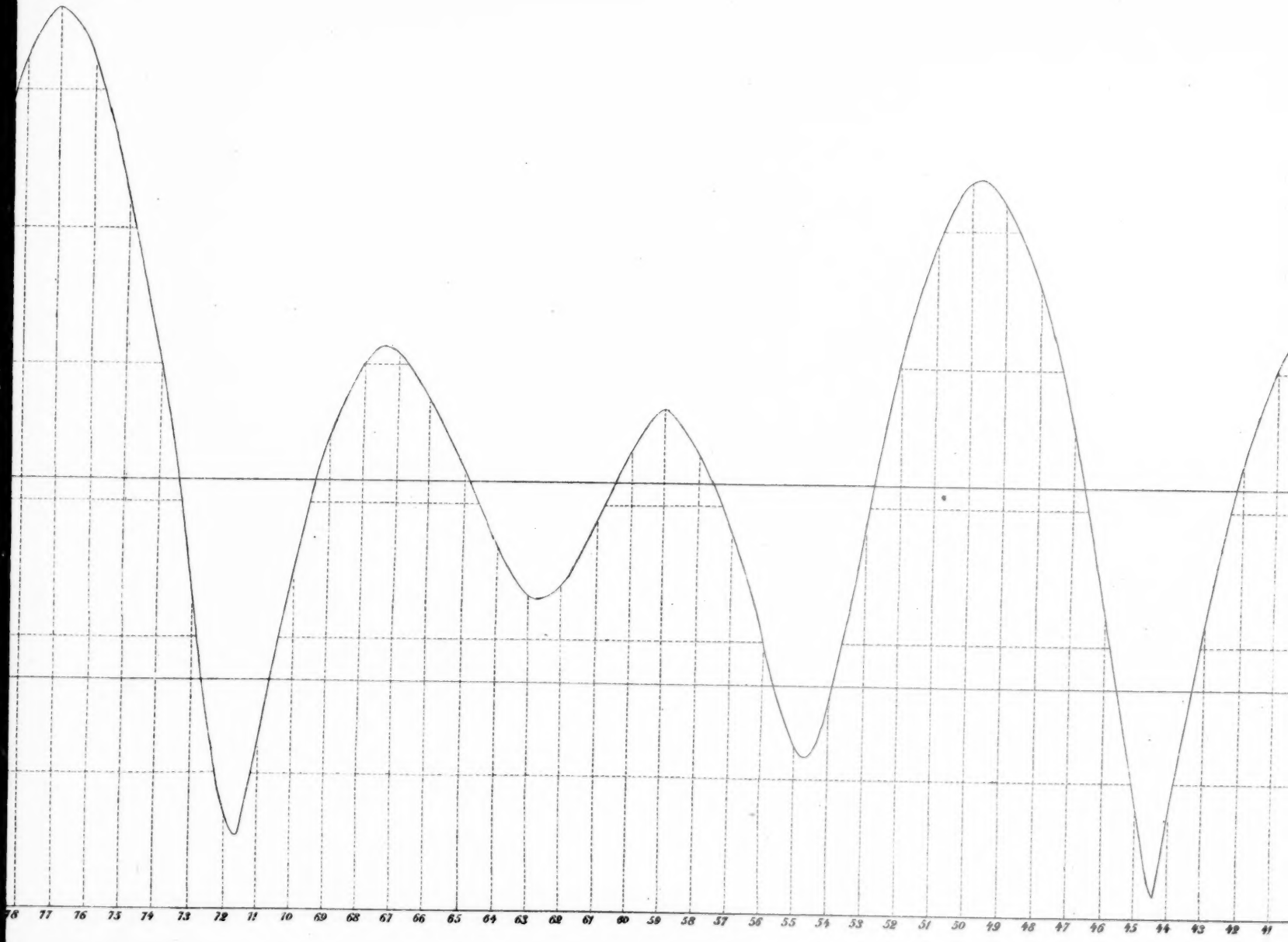

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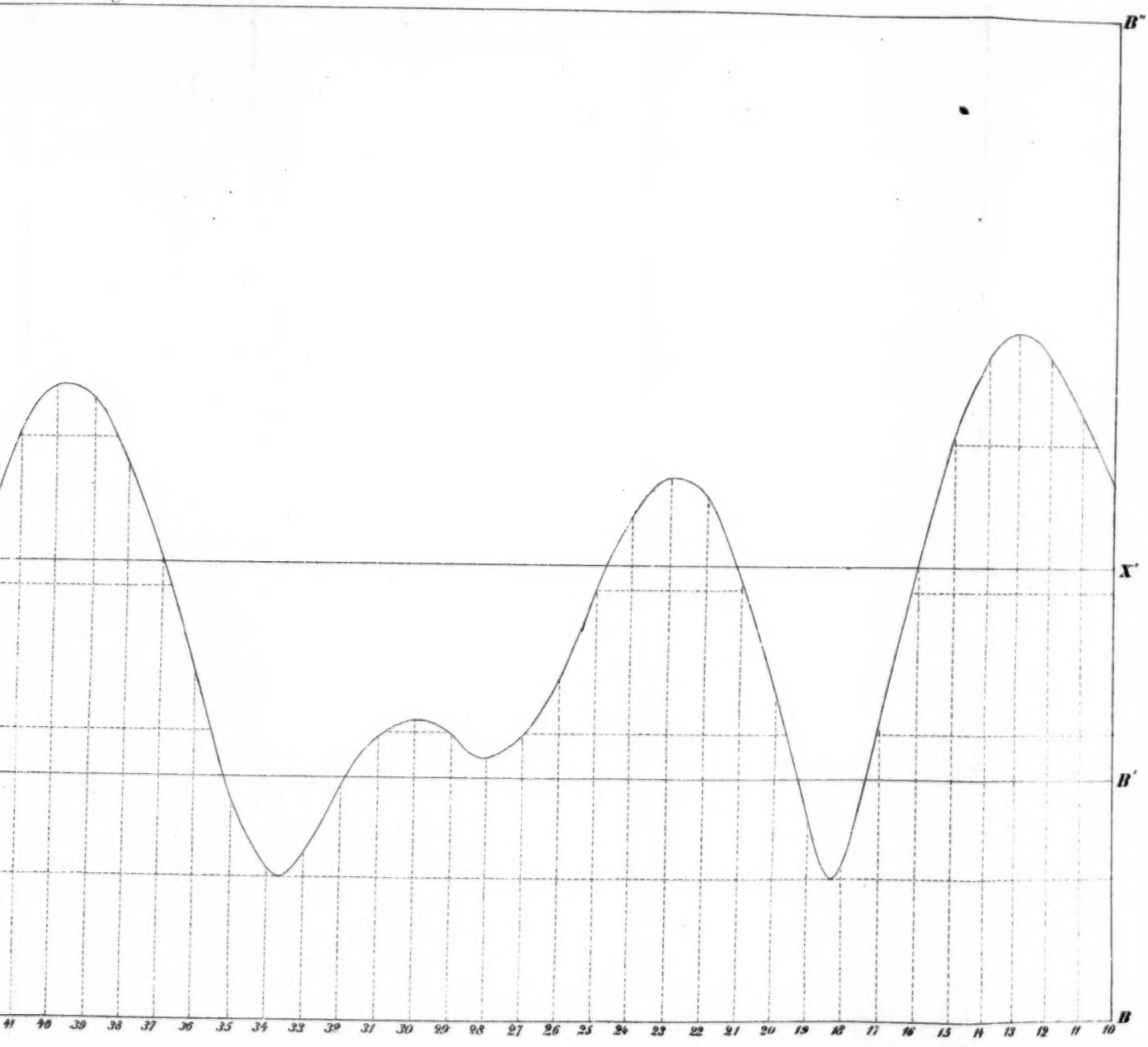
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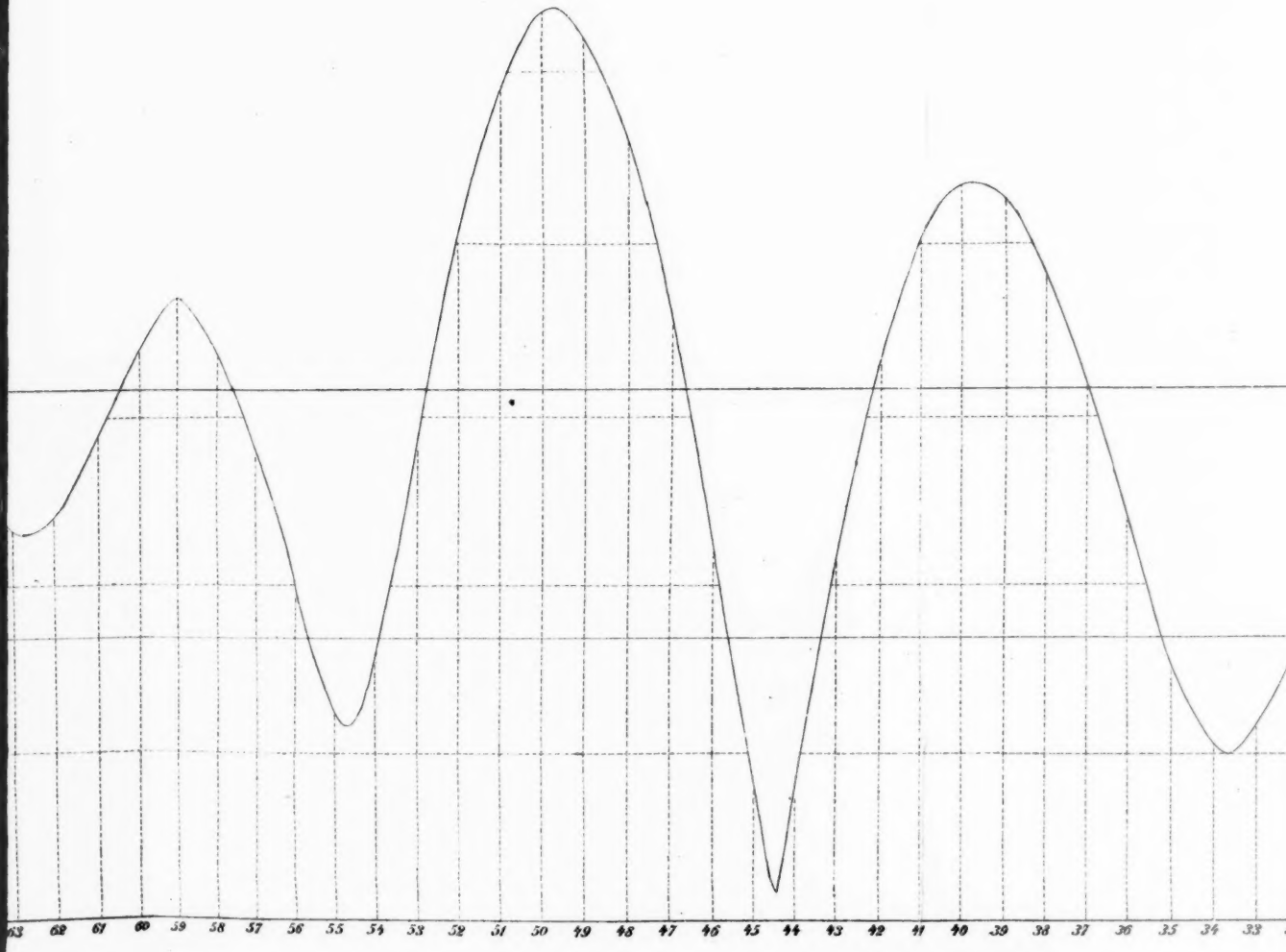

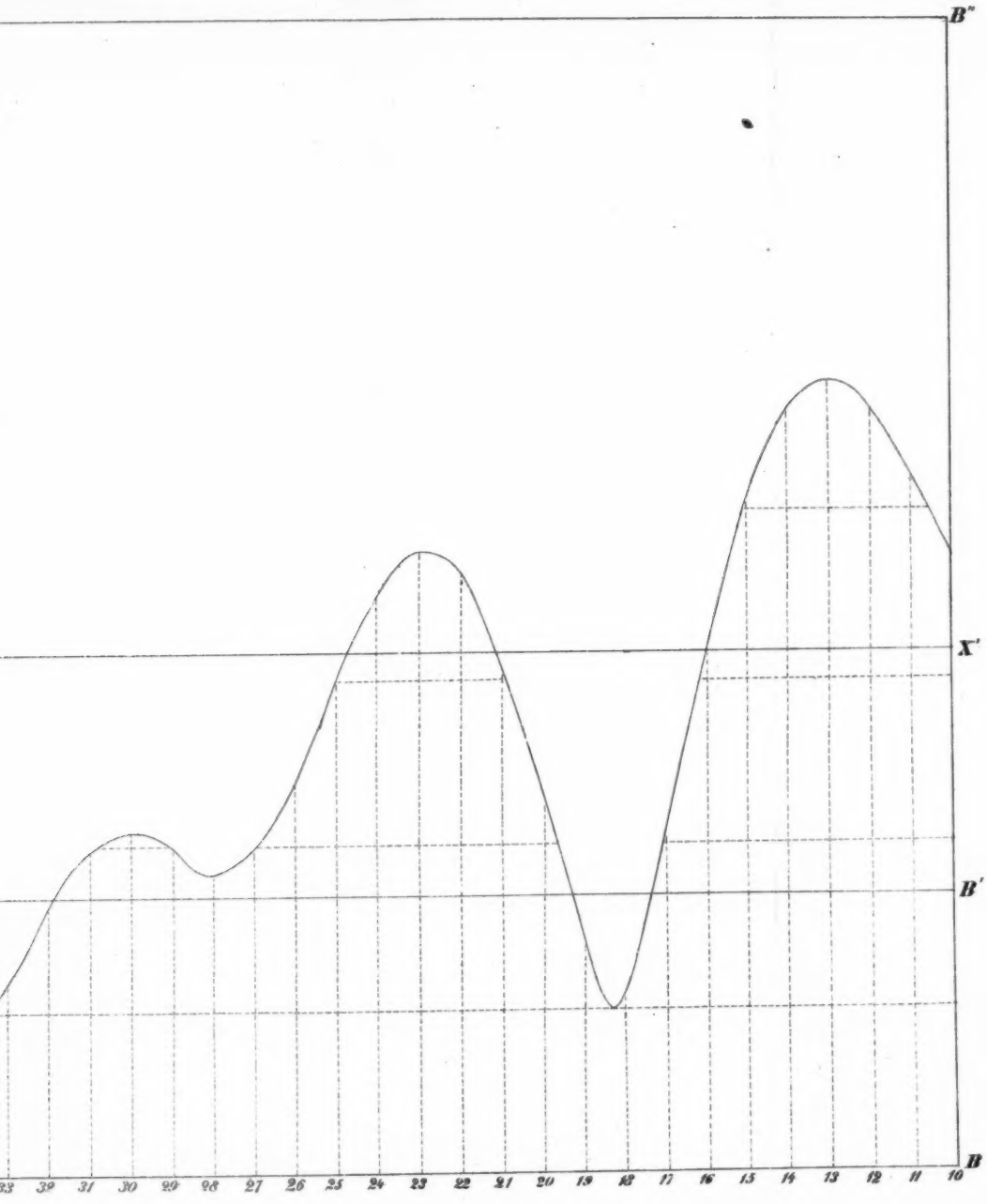
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